KOREA BASIC SCIENCE INSTITUTE

ANNUAL REPORT

ENGLISH VERSION

KOREA

BASIC

2015

ANNUAL

REPORT

SCIENCE

INSTITUTE



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KOREA BASIC SCIENCE INSTITUTE

2015

ANNUAL Report

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TOP 10 ACHIEVEMENTS OF KBSI IN 2015

01 Research Area

Elucidation of the properties of ion movement in Nafion electrolyte membrane using nanometer-level spatial resolution

Successful measurement of diffusion rate at the center and inner-surface of the hydrophilic channels in nafion electrolyte

Published in Angewandte Chemie (IF=11.336, Mar. 16, 2015) Dr. Oc Hee Han Santa Barbara, USA)

06 Management Area

Establishment of the foundation for international collaborative research with global institutes

Masdar Institute of Science and Technology (MIST) and the Petroleum Institute in UAE (Mar. 4-5)

Establishment of cooperative foundation for high-magnetic field and high-temperature su-perconductor magnet development fields with USA (Jul. 28)

Establishment of foundation for exchange and equipment with Institute of Scientific Instru-ments of Czech Republic (Dec. 2)

project on analysis of characteristic of nano magnetic particle, development of new nano-metal catalyst and properties analysis field with UAE Dr. Hae Jin Kim

02 Research Area

Development of nano capsule that separates water and oil for easy purification of contaminants

Proof of the possibility of coexistence of hydrophilic and hydrophobic materials on the same surface in contrary to the exist-

Published in Advanced Functional Materials (IF=11.805, Oct. 14, 2015) Dr. Ha Jin Lee (Joint research with Hanbat National Uni-

07 Management Area

Establishment of foundation for cooperation with various institutes on fusion research

KBSI - National Research Institute of Cultural Heritage - GRAST cultural heritage analysis and cultivation of

KBSI – Korea Institute of Oriental Medicine Establishment of foundation for research

03 Research Area

Installation and operation of 7 T MRI system for high-tech brain science and disease research (Ochang Headquarters)

Installation of customized biomedical Bio-HVEM that can directly analyze 3 dimensional molecular structures of biomaterials (Ochang Headquarters)

Improvement of reliability on analysis services and reinforcement of customer satisfaction management system through work standardization for analysis support

management system

instrumentation

08 Research Area

ultra-small portable mass spec-

Easy measurement of various toxic gases on site; and reduced weight by 1/7, reduced size by 1/4, and reduced electricity consumption by 1/3 compared to existing mass spectrometer

Technology transfer : Bioneer Inc. Dr. Hyun-sik Kim

09 Management Area

4 institutes and the commemora-

Hosted the groundbreaking of workplace nursery sharing with National Fusion Research Institute, Korea Research Institute of Bioscience & Biotechnology, and Korea Institute of Oriental Medicine

Hosted a policy debate for construction of substantive infrastructure that will be supported to women scientists and technicians

04 Research Area

(ISO) quality management system ISO 9001 certification

Acquisition of ISO 9001 Quality Management System certification from the International Organization for Standardization (ISO) for research and development of bio, environment, and nanomaterial analysis support services and basic scientific

services and establishment of quality

05 Research Area

Development of inspection technology for detecting defects from the nextgeneration semiconductor Technology for detecting accurate location of flaws with thermal imagery calculation of defects occurring in a stacked semiconductor chip Dr. Geon-hee Kim

Development of cryogen-free, ultra-low temperature probe station

Saving time and costs for more than twofold and improvement of the measurement precision for more than 50 % compared to the previous cryogenic probe station that depended entirely on imports Dr. Youn-seok Choi

10 Management Area

Contributed to the popularization of science through the operation of youthoriented 'Junior Doctor' and 'X-science' programs

Received grand prize in institutions sector at the 4th Korean Education Donation Awards in 2015 (2 consecutive years, supervised by Korea Foundation for the Advancement of Science and Creativity)

MESSAGE

In 2015, KBSI focused on establishing an international level of R&D platform for fundamental research. We provided analysis services, which is one of the original missions of the institute, and analyzed approximately 130,000 specimens for 5,726 academic and industrial researchers inside and outside of the country using 178 advanced analytical instruments. Based on such high-tech research equipment and analytical science techniques, we were able to publish a number of outstanding publications in distinguished journals and develop a test kit that can detect Norovirus within an hour as well as a portable mass spectrometer that can easily detect various harmful gases on site. To support equipment development projects in Korea, we established the foundation for localizing advanced research equipment by transferring the next-generation semiconductor chip defect detection technology and the cryogenic probe station technology which does not require refrigerant to small and medium-sized enterprises.

To be equipped with world-class research tools, KBSI has installed the Bio-HVEM and 7 T MRI at the Ochang headquarters and developed aanalytical research equipment including an In-situ Nano Property Analyzer, a 28 GHz Superconductivity ECR Ion Source Equipment, and a High-Precision Thermal Imaging Optical System. Based on these experiences, we are currently in progress of developing general-purpose equipment such as a "Tabletop Transmission Electron Microscope (TEM)", a "Secondary Ion Mass Spectrometer (SIMS)", and a "Non-Refrigerant NMR (High Sensitivity Nuclear Magnetic Resonance System)".

Most importantly, we introduced a variety of management systems to improve customer reliability and convenience. We also standardized analysis services and developed quality control systems by acquiring ISO 9001 Quality Management System Certificate from International Standard Organization (ISO) in bio-environment and nano-material research fields. We promoted specialization and integration of each regional center, including the localized installation of biomedical research equipment in Seoul Western Center and establishment of aged-animal facility in Gwangju Center. Furthermore, we laid the groundwork for practical collaboration among institutions such as Korea Institute of Oriental Medicine, Scientist and Engineers' Association of National Research Institutes, National Research Institute of Cultural Heritage, Pohang Accelerator Laboratory, and more. With the specialization and profession strategies of KBSI, we expect to create a platform for a group of Korean and overseas scientists to research without limitations and lead the world's scientific field. We have all gathered our strengths and skills for the advancement of KBSI in 2015. As a result, we have achieved outstanding performances; we were selected as an institute of excellence in management · research, we received Class 2 in integrity evaluation, and a presidential citation in group performance evaluation of national research and development. Please show us your support and interest as KBSI becomes an advanced and leading research institute by contributing to a creative economy and playing a pivotal role in the fundamental research platform, which is the foundation of national industry and national competitiveness.



"

Open World-class Research Platform, KBSI

April, 2016 President of Korea Basic Science Institute

Kwang Sik Lee

VISION

MISSION

HISTORY



			MAIN FUNCTIONS	tion of high-tech large research equipment
1988-1999	1988. 08.	Korea Basic Science Center (KBSC) established as an affiliate of Korea Science & Engineering Foundation		Development of ana-
	1992. 03.~04.	Four Local Centers (Seoul, Busan, Daegu, Gwangju) established		lytical equipment and technologies through
	1999. 05.	Established as a corporate body		analytical science research
	1999. 12.	Jeonju Center established		
2000-2005	2001.01.	Name changed to Korea Basic Science Institute (KBSI)	KBSI MAIN VALUE	
	2001.11.	Chuncheon Center established	MAIN VALUE	
	2005.05.	Suncheon Center established		
	2005. 10.	'National Fusion Research Institute' established affiliated organization	Basic	Customer
			research support	value realization
2006-2015	2006. 04.	Ochang Center established		
	2006. 05.	Gangneung Center established	Key roles	Benefit to custo
	2008.04.	Jeju Center established	-	
	2009. 08.	National Research Facilities Equipment Center (NFEC) established		
	2012. 12.	Western Seoul Center established		

VISION & GOAL

Open World-class Institute, KBSI

Conduct R&D on research facilities & equipment and analytical S&T, joint research and support for basic science promotion





PERSONNEL, EQUIPMENT & BUDGET

As of December 31, 2015

PERSONNEL

CEO	Researchers	Engineers	Administrators	Analyst	Unlimited contractual workers	Total
1	148	54	48	9	2	262

EQUIPMENT

Category	Daedeok	Ochang					Loca	l area					
	Head- quarters	Head- quarters	Seoul	Busan	Daegu	Gwangju	Jeonju	Chun- cheon	Sun cheon	Gang neung	Jeju	Western Seoul	Total
Equipment	169	153	64	52	29	42	28	22	7	8	10	32	616
Amount	65,050	95,694	16,562	18,290	7,049	12,228	11,099	7,186	2,016	2,832	2,795	18,298	259,099

BUDGET

Operating Revenue	
Category	Budget
Government Contribution	82,216
1. Basic Fund	17,279
2. General R&D Projects	47,330
3. Facilities & Equipment	17,607
4. Loan Payment & Interests	-
Income	24,346
1. Public (government) projects	16,300
2. Private projects	250
3. Other R&D projects	-
4. Technology supports	6,852
5. Technical fees	150
6. Others	794
Total	106,562



Unit : Million won

* Standard: Over 30 million won of introduction price

Unit : Million won

Operating Expense	
Category	Budget
Wages	20,946
1. Research Personnel	17,902
2. Legal liability amount	1,600
3. Retirement Reserves	1,444
Direct Research Expenses	61,381
1. In-house projects	47,330
2. Public (government) projects	12,000
3. Private projects	184
4. Other R&D projects	-
5. Technology supports	1,867
Operating costs	5,539
Facilities and equipment	17,607
Others	1,089
Total	106,562

KBSI NETWORK

01 DAEDEOK HEADQUARTERS

Biological Disaster Research, Drug & Disease Target Research, Nano-Bio Electron Microscopy (EM) Research, Advanced Nano-surface Research, Instrumentation Development Support, Optical Instrumentation Development, Spin Engineering Physics Research

02 OCHANG HEADQUARTERS

Protein Structure Research, Bioimaging Research, Biomedical Omics Research, Geochronology Research, Environmental Monitoring and Research, Mass Spectrometry and Advanced Instrumentation Research



05 DAEGU CENTER

Functional Materials Research



09 SUNCHEON CENTER

Energy Materials Research



Advanced Material Science Research

11 JEJU CENTER

Marine Biology Research









Ion Beam Application Research, Molecular Materials Research



08 CHUNCHEON CENTER

Disease/Specific Molecular Imaging Research



12 WESTERN SEOUL CENTER

Omics System Research, Functional Interface Research



06 GWANGJU CENTER

Advanced Aging Science Research

07 JEONJU CENTER Nano/Carbon-based Materials

03 SEOUL CENTER

Research

Environment Risk & Welfare Research, Space-time Resolved Molecular Imaging





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KBSI supports national basic science research and performs and specialized research based on regional industrial fields through the institute's 12 bases across the country.

2015 KBSI RESEARCH ACHIEVEMENTS

STATISTICAL TRENDS OF ANALYTICAL SERVICES

Unit : No. of cases, No. of samples, No. of users





USERS 5,726	

54.7 %	Universities 3,132	22.1 %	Small & Medium Companies 1,268
• 13.6%	Government-funded Research Institutes 777	• 3.8%	Large Companies 216
• 3.0%	Others 175	2.8%	National Institutes 158



USER PUBLICATIONS Unit : No. of papers

565

SCI



High impact journals : Journal publications in the top 5% by JCR subject field, or above IF 10 (including NSC and the affiliated journal of NSC)





PUBLICATION BY AUTHOR TYPE

Unit : No. of papers



TECHNOLOGY TRANSFERS

Unit : No. of cases, No. of institutes, Million won



Number of technology transfers





Transferred institutes 14

Application

22

Registration





Technology fee revenue **193**

Description of photograph

2015 KBSI Science Image Contest Grand Prize Winners' Works <Planet Earth Travel of Dandelion Seeds>, Han-bit Kim (Chungnam National University) SEM image of conductive organic molecular structure (X 1,000)

ADVANCED ANALYTICAL SCIENCE RESEARCH

KSBI focuses on 3 representative research areas for better achievements while carrying out various tasks including analysis services, collaborative research, education, and technology transfer & commercialization based on state-of-the-art research facilities and equipment.

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Geochronology Research Environmental Monitoring and Research Nano-Bio Electron Microscopy Research Advanced Nano-Surface Research Molecular Materials Research Functional Materials Research

BASIC SCIENCE

REPORT 2015

Bioconvergence Analysis

Bioimaging Research Biomedical Omics Research Marine Biology Research Omics System Research

Environmental & Material Sciences

Instrumentation Development Support Optical Instrumentation Development Spin Engineering Physics Research Mass Spectrometry and Advanced Instrument Ion Beam Research

Bioconvergence Analysis

Through the convergence of analytical techniques in various biological science disciplines, KBSI carries out research and developments on analytical science, and provides support and collaborations to the national researchers. The goal is to promote the basic science which is the core power of science and technology advancement, and to provide scientific solutions to the national and social problems in Korea. Especially, the Division of Convergence Biotechnology consists of several teams that specialize the following research topics: biological disaster analysis, drug & disease target studies, protein structure determination, bioimaging research, biomedical OMICS analysis and etc. Through the joint efforts of the teams, the development of new analytical techniques in biological sciences is pursued.



Biological Disaster Research

Biological disaster researches aim at the development of problem-solving techniques for disaster-causing microorganisms in the field of agriculture, animal industry and fishery. Main research areas cover the ecological analyses of microbes, the concentration and detection of foodborne pathogenic virus, the analysis of fish disease and the early screening method of algal bloom bacteria. (Daedeok Headquarters)

Main Research Activity

As a representative highlight of scientific achievement in the field of biological environmental disaster, researchers performed ecological analyses of microbes in various environments and developed a novel technology to efficiently concentrate norovirus, a major foodborne pathogenic virus, with sword bean lectin protein and succeeded in transferring the technology to small and medium-sized bioventure.

Representative Research Case

Occurrence of viable, red-pigmented haloarchaea in the plumage of captive flamingoes Viable red-colored archaeal strains classified as extremely haloarchaea was isolated from the plumage of flamingoes in captivity and was analyzed metagenomic sequences of the feathers for targeting feather-attached haloarchaea, and compared their pigments to those found in flamingo feathers and feed. The coincidence of the carotenoid-based pigments in the haloarchaeal cells and the avian feathers suggests that haloarchaea may be considered as an environmental factor affecting the plumage coloration.

Major Achievements

	Category	Achievements		
	Research Result	Publications 30 (SCI 30)	Presentations Domestic 21	 /
	Analytical Methods	 Development of label-fri Rapid concentration of Metabolic labeling of the molecule with polysialic Development of microber metagenome sequence 	ree proteome analysis for a human norovirus le unnatural sialic acid on a c acid (PSA-NCAM) vial community analysis bas es	inii i ni
	Projects	 Development of biological disaster analytical technic Identification of drug-binding proteins and functional study Proteome analysis of induced stem cells derived from Study and detection system of food-borne viruses Development of cutting-edge forensic analytical tech Isolation and bioprospecting of novel species of archaea free Genomic study of non-culturable microorganisms in Development of a rapid biosensor system to detect NBIT Based kinase signal control, analysis of interactions to 		
	Equipment	LC-MS/MS 2D LC-MS/MS Carbohydrate Analysis Amino Acid Compositio	System on Analysis System	



ANALYSIS SERVICE

71 Cases **470** Samples 48 Users



Metagenomic sequences and phylogenetic tree isolated from flamingo feathers

Patents Application 2 Registration 5

mals

eural cell adhesion

d on

ques using Chemical Proteomics m patients

hniques rom extreme environments food and human

hyman noroviruses

between protein kinase



LC-MS/MS Synapt G2



Next Generation Sequencer, MiSeq



High Performance Liquid Chromatography

Drug & Disease Target Research

ANALYSIS SERVICE

153 Cases 7.538 Samples 71 Users

Our research field is development of analytical technology and establishment of infrastructure for translational research about diagnosis, therapy and prevention of disease based on in-country fundamental study. (Daedeok Headquarters)

Main Research Activity

- Development of translation research analytical technology based on High content screening system and Protein-protein interaction
- New analytical technology development for mode of action (MOA) investigation of drug candidates

Representative Research Case

3D structural elucidation of multi-walled vesicles having stepwise drug release behavior We utilized biocompatible and degradable polymers and a new method, emulsification-induced assembly to form onion-like vesicles having the unique stepwise drug-releasing behavior. In addition, we interpreted the 3D multi-walled structure of the vesicles using cryo-electron tomography which allows 3D visualization of the nanoparticles at molecular resolution in a hydrated condition.



3D structural elucidation of onion-like vesicles with water channels (upper panel) using cryo-electron tomography (lower panel)

Maior Achievements

Category	Achievements		
Research Result	Publications 11 (SCI 10)	Presentations Domestic 17 International 4	Patents Application 6 Registration 3
Analytical Methods	 Screening of protein- Screening of small m interaction by cellula 	-protein interaction by ce nolecule inhibitor targeting rr imaging	llular imaging g protein-protein
Projects	 Development of rapid Acinetobacter bauma Operation of drug an Support of efficiency Development of phanusing cell imaging Development of biompathogen through Un Development of linker penetration mechanic 	d detection technology o annii using antigen-antibu ad disease target research improvement of domestic rmacological action scree narker exploration and di rine Proteomics ed imaging technology fo ism using cell affinity nan-	f multiple drug resistant ody reaction n team protein synthesis equipment ening analysis technology agnosis derived from infective r visual investigation of cell oparticle
Training of Equipment	Confocal Microscope	Training Course	
Equipment	Microscopic Imaging S (Confocal Microscopy, MALDI TOF/TOF MS LCQ-MS Protein Sequencing Sorter/FACS	System Tissue Faxs, Elecron Micro S System	scopy)

· Development of new analytical methods, supporting analytical service and collaboration with other group **Representative Research Case**

Development of protein reaction inhibitors using peptide mimetic Protein-protein interactions are attractive targets for drug design due to their fundamental role in biological function. This research was focused on the development of new peptide based inhibitors which were blocking the interaction between Polo-like kinase 1 and its binding partner called the PBIP1.

Protein Structure Research

Determination of protein-protein complex structure

We determined their complex structure using X-ray and described their biological effects when their interaction was blocked by inhibitors.

Major Achievements

Main Research Activity

Category	Achievements				
Research Result	Publications 26 (SCI 24)	Presentations Domestic 7 International 2	Patents Application 2 Registration 2		
Analytical Methods	 Mg++ induced prote Stereospecificity and Probing the intramole by 15Nz-exchange N Hemolytic activity ar PET imaging using r pKa analysis using g Structure and interact 	in folding analysis alysis of peptidoglycan-a ecular motion of a transcri NMR spectroscopy nalysis using HPLC adiolabeled oleanolic ac glutamine side chain ction of the MST1-RASS	associated lipoprotein iption factor on the same DN/ id derivative F5 SARAH domain complex		
Projects	 Analysis of drug binding for establishment of fragment-based leading molecules research platform Development of polo-box domain (PBD) inhibitor of polo-like kinase 1 (Plk1 and analysis of structure using NMR/X-ray Development of new drug of antibody fingerprint mapping using high magnetic NMI Development of vaccine protein properties and structure analysis technologies for permission of green vaccine against national crisis of domestic animal dise. 				
Training of Equipment	NMR Basic School				
Equipment	 900 MHz Cryogenic N 700 MHz Cryogenic N 400 MHz NMR Spectr Macromolecular X-Ra Macromolecular Autor Auto-Isothermal Titrati Protein Synthesizer 	MR Spectroscopy •800 M IMR Spectroscopy •500 I roscopy •CD Spectropola y and Crystallization System natic Crystallization System on Calorimetry •Multi-An MicroPET/CT/SPECT Sys	IHz Cryogenic NMR Spectrosc MHz NMR Spectroscopy arimeter m n (Mosquito) gle Light Scattering tem • DynoPro Plate ReaderII		

eening System High



The general research theme of our group is to determine the mechanism of protein-protein interaction and development of its inhibitors based on the complex structure using NMR and X-ray. (Ochang Headquarters)

· Development of small molecule inhibitors based on the protein complex structure

ANALYSIS SERVICE

297 Users

1.309 Gases 7.548 Samples



Chemical structure of peptide inhibitor and the complex structure of PLK1 with peptide inhibitor

ed lipoprotein ctor on the same DNA

olo-like kinase 1 (Plk1),

sing high magnetic NMR analysis technologies domestic animal diseases

genic NMR Spectroscopy /IR Spectroscopy

uito) Scattering



Macromolecular X-ray



Multiple Protein/Peptide Synthesizer



900 MHz Nuclear Magnetic Resonance Spectrometer

Bioimaging Research

ANALYSIS SERVICE 165 Cases

782 Samples 44 Users

We perform clinical research related to human brain function and brain disease based on human 3 T and 7 T MRI systems, and preclinical research using animal 4.7 T and 9.4 T MRI systems. (Ochang Headquarters)

Main Research Activity

- Development of high field 3 T and 7 T MRI pulse sequence, RF coil, and image reconstruction method
- · Research of human brain structure and function, early diagnosis of brain disease, and clinical and preclinical research using various MR imaging techniques
- · Development of analytical methods through state-of-the-art equipment, professional analytical service, and collaboration with other groups

Representative Research Case

MR assessment of cerebral blood volume and mean vessel size using ultrashort echo acquisition

With UTE-MR imaging technique and T2-contrast agent approved by the US Food and Drug Administration (FDA) (e.g., SPION), we demonstrated the feasibility of the cerebral blood volume and mean vessel size in a small animal model. It suggests that the method may enable longitudinal follow-up investigations of microvasculature brain disease.



MR imaging of nude mice before and after SPION administration in the cortex, cerebellum, and olfactory bulb: (A)-T2* image, (B) and (C): CBV map; (D): T2* map; (E) and (F): mVSI

Major Achievements

Category	Achievements			
Research Result	Publications 21 (SCI 21)	Presentations Domestic 17 International 12	Patents Application 2 Registration 1	
Analytical Methods	 Magnetic resonance imaging apparatus and magnetic resonance spectroscopic method using the same Development of MR assessment of cerebral blood volume and mean vessel size using UTE Analytical method of tumor-targeted prodrug for cancer treatment and imaging 			
Projects	 Installation and application of human MRI equipment operation of drug and disease target research team Identification of drug-binding proteins using in vivo imaging technology 			
Training of Equipment	• 3 T Human MRI Training Course • 7 T Human MRI Training Course			
Equipment	• 3 T Human MRI • 7 T Human MRI • 4.7 T Animal MRI • 9.4 T Animal MRI			



nan MR



nan MRI



9.4 T Animal MRI

Biomedical Omics Research

Biomedical Omics Research Group is devoted to the development of "Omics" technologies based on mass spectrometry and their applications with an ultimate goal of understanding protein and metabolic networks as well as their role in diagnosis and therapy. (Ochang Headquarters)

Main Research Activity

- Development of multi-Omics technologies using advanced mass spectrometers
- Application of Omics technologies for discovery of new targets involved in various diseases
- Qualitative and quantitative mass spectrometric analyses of glycoproteins

Representative Research Case

High-throughput MS platform for N-linked glycoproteome analysis We have developed Integrated GlycoProteome Analyzer (I-GPA) including Automated Identification and Quantitation of Site-Specific N-Glycosylation, which combines methods for tandem mass spectrometry with a database search and algorithmic suite.

Major Achievements

Category	Achievements			
Research Result	Publications 32 (SCI 29)	Presentations Domestic 11 International 2	P R	
Analytical Methods	 Mass spectrometric an peptide affinity enrichn Development of high-tt In-depth analysis of site plasma Discovery of disease b 	alysis of cancer biomarker fr nent nroughput quantitative N-gly e-specific N-glycosylation of iomarker by MALDI-MS profi	o ca	
Projects	 High throughput biomarker discovery and validation by ma Discovery and functional studies of disease-related protein human chromosome 11 Development of glycan-humanized mouse model for non- Mass spectrometry based disease screening for improving Quantitative analysis of plasma protein based on the high- mass spectrometry using peptide antibody Development of a drug screening platform using human n for alzheimer's disease Development of general-purpose system for natural produ- search engine based on mass spectrometry Analysis of spilled oils and related contaminants Performance evaluation of domestic MALDI-TOF 			
Training of Equipment	Education of MS-Based	Proteome Analysis		
Equipment	 15 T FT-ICR MS Hybrid FT-ETD Mass Spee Two-Dimensional Gas Ch System High-Speed Q-TOF Mass MALDI/ESI Synapt High I Matrix-Assisted Laser De Imaging System Triple Quadrupole Mass S 	ectrometer (Orbitrap-Elite) Iromatography/High Resolution s Spectrometer (TripleTOF 5600 Definition MS G2 sorption Ionization Mass Spect Spectrometer System)+)+	
	To Be Installed • Orbitrap Fusion			



ANALYSIS SERVICE

188 Users

326 Cases

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-

Development of Glycopeptide Analyzer(GPA) for mass spectrometry-based glycoproteomics and glycoprotein analysis as a bio-drug

Patents Registration 4

m serum with

an analysis system proteins in human

ng

ass spectrometry ins from

-clinical study ng the quality of life resolution targeted

neural stem cell models

uct fragment ion

Mass Spectrometry

, 6600)

ometer (MALDI-MS)



Hybrid FT-ETD Mass Spectrometer



High-Speed Q-TOF Mass Spectrometer



15 Tesla Fourier Transform Ion Cyclotron Resonance (15T FT-ICR) Mass Spectrometer System

Space-time Resolved Molecular Imaging Research

ANALYSIS SERVICE

• • • • • • • • • • • 724 Cases 3.671 Samples 205 Users

With femtosecond laser spectroscopic system, super resolution microscope, state-of-the-art scanning and transmission microscopes, and high-end imaging mass spectrometry, we provide networking opportunities for all researchers through multidisciplinary dynamic imaging. (Seoul Center)

Main Research Activity

- Real time imaging for anti-bacterial activity of macromolecular polymer with super resolution confocal microscope
- · Development of femtosecond time-resolved two-dimensional electron spectrometer and nonlinear laser optical measurement techniques
- Characterization of polymer nano-wire transistor using Low Dose transmission
- electron microscopy
- Proteomic research of neurodegenerative diseas

Representative Research Case

High Aspect Ratio Conjugated Polymer Nanowires for High Performance Field-Effect Transistors and Phototransistors

We synthesized a highly crystalline DPP-based polymer. High- and low-molecular weight (MW) DPPBTSPE fractions were collected by Soxhlet extraction and were employed to investigate their unique charge transport properties in macroscopic films and single crystalline polymer nanowire (SC-PNW), respectively. The field effect transistors made of SC-PNWs exhibited remarkably high carrier mobility of 24 cm² V⁻¹ s⁻¹. In addition, phototransistors (PTs) made of SC-PNW showed very high performance in terms of photoresponsivity (R) and photo switching ratio (P). The average R of the SC PNW-based PTs were in the range of 160170 A W⁻¹ and the maximum R was measured at 1920 A W⁻¹, which is almost three orders higher than that of thin film-based PT device. High crystallinity and the growth mechanism were identified using high voltage (300 kV) low dose transmission electron microscopy imaging.

Major Achievements

Category	Achievements		
Research Result	Publications 21 (SCI 21)	Presentations Domestic 10 International 2	Patents Registration 2
Analytical Methods	Real time imagin Label-free quant Amplification of quasi-null polariz Phase analysis o electronic spect Low dose TEM i	ng for antibacterial activity o itative proteome analysis optical rotatory dispersion of zation detection method of quantum coherence in two roscopy maging	f macromolecular polymer of chiral molecule using o-dimensional
Projects	 Development of optics analytical Multidimensiona Development of technology using Development of material of DNA 	 Low dose TEM imaging Development of industry-academic cooperation of space-time laser optics analytical equipment with advanced future technology Multidimensional spectroscopy and chiral optical measurement Development of high-spatial resolution chemical state analysis technology using STEM-EELS Development of surface reformed magnetic bead used as an essential material of DNA/RNA extraction method, and nucleic acid extraction kit 	
Training of Equipment	Femtosecond Mu Super Resolution 300 kV Field Emis Ion Mobility Mass Amino Acid Com	ulti-Dimensional Laser Spectr Confocal Microscope ssion Transmission Electron I s Spectrometer • Focus Ion E position Analyzer	roscopic System Microscope 3eam ∙ SQUID
	To Be Installed	ICEMS	

^{9.4} T Imaging FT-ICR MS

High Spatial & High Energy Resolution Transmission Electron Microscope



DPPBTSPE polymer nano wire and schematic description of transistor

Advanced Aging Science Research

In order to obtain critical results for degenerative disease and regeneration through collaborative research in university and research institutes, we carry out the supporting of age-related research and construction of the infrastructure for utilization of an aging research cluster. (Gwangju Center)

Main Research Activity

- · Based on utilization of researcher in aging science and future demand-related surveys, we prepared proposal and ensured budget for 'Environment and improvement project for Animal Facility of Aging Science'.
- · Gwangju center has built a new infrastructure of multimodal analysis for animal model, including rodents and fly, for aged and disease study (i.e., aging, degenerative disease, and osteoporosis etc.)
- New installation and analytic support of in vivo Micro-CT

Representative Research Case

Photoexcited porphyrins as a strong suppressor of β-Amyloid aggregation and synaptic toxicity

Photoexcited porphyrin molecules inhibit β-amyloid aggregation and rescue postsynaptic toxicity and behavioral defects in the Drosophila Alzheimer's disease model under blue light.

Maior Achievements

Category	Achievements	
Research Result	Publications 5 (SCI 5)	Presentations Domestic 7
Analytical Methods	 Analysis of photothera photosensitizers Analysis for developm 	peutic agent of Alzheimer's disease us ental control of primordial germ cells
Projects	 Studies on the novel n by nuclear transcription Mechanism of mitocho 	nechanism in mitochondria n factor ndrial dysfunction in alzheimer's disease
Training of Equipment	Understanding and pra	ctice of Confocal Microscope
Equipment	Laser Confocal Scannin Online LC-NMR/MS Multi-TEM Animal Facility of Aging Super-Resolution TIRF M Real-Time PCR Automatic Chemistry Ar In Vivo X-Ray Radiograp	g Microscope Science Microscope Ialyzer Ihy Micro-CT
	To Be Installed • Nonlinear Multi-Excitation • Preclinical Luminescence	n in Vivo Imaging System e & Fluorescence Bioimaging System

Super Resolution Confocal Microscope





ANALYSIS SERVICE

122 Users

486 Cases

6.123 Samples

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Diagram for inhibition of Aß self-assembly into fibril ex vivo and Aß synaptic toxicity by blue LED lightsensitized TPPS using Drosophila Alzheimer model

disease using



Laser Confocal Scanning Microscope



Super-Resolution TIRF Microscope



In Vivo X-ray Radiography Micro-CT

Disease/Specific Molecular Imaging

ANALYSIS SERVICE **466** Cases 14.380 Samples

85 Users

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Biological imaging of diseases is a multidisciplinary field, in which the images produced reflect cellular and molecular pathways and in vivo functional mechanisms of disease in living subjects. Biomolecular imaging techniques will guide to understand characteristics of diseases and discover new diagnostic, therapeutic and preventive strategies at the early stages for the treatment of human diseases. (Chuncheon Center)

Main Research Activity

- Studies on drug mechanism, new drug discovery and screening, and development of nanobiomaterial-based diagnostic/therapeutic agents
- Biological and disease imaging studies in cells and in vivo disease animal models (i.e., cancer, depression, atherosclerosis, stroke, and osteoporosis, etc.)
- · Performance of high quality imaging researches with advanced bioimaging equipment, professionally technical support and research collaboration

Representative Research Case

The multifunctional miniaturized smart patch enabling to monitor vital signs and drug delivery

This study showed cephalopod-inspired dry adhesives integrated with physiological sensors, drug-delivery actuators, and therapeutic nanoparticles in an ultrathin and stretchable format. Wireless connection of the electronic patch through a Bluetooth-enabled band allows data transmission in real time and provides a path for remote diagnostics and treatments, forwards bioinspired "smart medical skin".



The multifunctional miniaturized smart patch enabling to monitor vital signs and drug delivery

Major Achievements

Category	Achievements		
Research Result	Publications 18 (SCI 18)	Presentations Domestic 4 International 1	
Analytical Methods	The multifunctional min and drug delivery	niaturized smart patch enabling to monitor vital signs	
Projects	 Psychological verificat Multi-photon biomedic Development of slimm 	ion of stress bio-markers al imaging using biocompatible nanomaterials ing materials and products using oriental medicine	
Training of Equipment	Confocal laser scanning Fluorescence/biolumine Electron microscope ed	g microscope education for medical BIT students escence bioimaging education for medical BIT students lucation for medical BIT students	
Equipment	Energy Filter Transmiss Multi-Photon Confocal Luminescence and Flu Intravital Multi-Photon Variable Pressure Field Selective Plane Illumin Luminescence and Flu in vivo Imager	sion Electron Microscopy I Laser Scanning Microscope System iorescence Animal Imaging System Confocal Laser Scanning Microscope I Emission Scanning Electron Microscope ation Microscopy iorescence Imaging System with Micro-CT	



Pressure Field Emission Scanning Electron cope



al Multi-Photon Confocal Laser Scanning cope



scence and Fluorescence Animal Imaging System

Marine Biology Research

We have been performing and supporting high-quality researches about biomedical manufacturing technology, and eco-friendly environment recoveryrelated studies via our advanced analysis equipment. (Jeju Center)

Main Research Activity

- · Development of new oceanic microalgae cultivation system and applicable functional substances
- Development of marine organism-derived functional substances
- · Studies about physiology & ecology of marine-organisms and find internal secretion factors
- · Characterized analysis of marine bio-derived samples and supporting research via advanced analysis equipment.

Representative Research Case

Development of bioflocculation of oceanic microalga Dunaliella salina using bloom-forming dinoflagellate Heterocapsa circularisquama

We firstly developed bioflocculation technology of Heterocapsa circularisquama on the oceanic Chlorophyta Dunaliella salina for 24 h of incubation time. To screening effect of bioflocculation of Heterocapsa circularisguama, biodiesel-producing species Chlorella, Nannochloropsis, and D. salina was mixed with H. circularisquama. In the results, D. salina specifically flocculated by H. circularisquama and the composition of fatty acid methyl esters exhibited more suitable cetane number and iodine value in the flocculated biomass compared to EN14214 and ASTMD6751 biodiesel standards.

Maior Achievements

Category	Achievements	
Research Result	Publications 16 (SCI 16)	Presentations Domestic 7 International 1
Analytical Methods	Rapid preparation of oceanic microalga Chlorella Vu electron microscope	
Projects	Effect of the periodic changes in melatonin secretion on fish biological rhythms	
Training of Equipment	Field equipment training for LINC business group stud Field equipment training for UST intern students	
Equipment	Organism Component Separation Analysis System Field Emission Scanning Electron Microscopy System Inductively Coupled Plasma Mass Spectrometry	



ANALYSIS SERVICE 93 Cases . 787 Samples 26 Users







Bioflocculation effect of Dunaliella salina by Heterocapsa circularisguama and flocculation activity, and changes of main fatty acid methyl esters methyl palmitate (C16:0), methyl stearate (C18:0), cis-9-oleic acid (C18:1) which significantly affecting biodiesel properties



Variable Pressure Field Emission Scanning Electron Microscope with Scanning Transmission Electron Microscope

Headspace Gas Chromatograph Tandem Mass Spectromete



Organism Component Separation Analysis System (IC3000)

ulgaris for scanning

dents from Jeju University

Omics System Research

ANALYSIS SERVICE

326 Cases **3,116** Samples 131 Users

Metabolic profiling research has been performed to discover biomarkers for disease-therapy/natural product-food/environmental field by using the integrated analytical platform established. (Western Seoul Center)

Main Research Activity

- Biomarker discovery and identification of pathway of cardiovascular disease, metabolic syndrome, cancer etc.
- · Hepatic metabolism study associated to effect of natural products in fatty liver
- · Identification and quantification of marker compounds in environmental sample matrices
- Development of NMR/MS-based integrated metabolomics analytical method

Representative Research Case

Biomarker discovery of myocardial infarction using serum metabolite profiling based on LC-MS Biomarker discovery of myocardial infarction using serum metabolite profiling based on LC-MS and presentation of analytical technology to observe gender-specific metabolic pattern differences between healthy controls and patients with MI

Major Achievements

Category	Achievements			
Research Result	Publications 22 (SCI 22)	Presentations Domestic 35 International 7	Patents Application 1	
Analytical Methods	Metabolic characteriz Fast determination of Quantitative analysis by liquid chromatogra Development of techni	ation in biological tissu polar amino acids by C of heterocyclic amines aphy coupled with tand que for identifying respo	e samples using HR-MAS NMR E-MS in urine em mass spectrometry nse of burdock to copper stress	
Projects	 Development of NMR diagnosis and treatme Development of analy sources using metabe Development of multiple disease using fusion ressisted Development of phane using cell imaging Profiling studies for pro- 	Based metabonomics ent of chronic kidney di trical methods for tracin blomics technology e diagnostic and therapeu search of metabolomics an macological action scree ediction and manageme	/chemometrics for sease ig environmental quality and tic technology in cardiovascular nd bio-imaging tening analysis technology int of the metabolic syndrome	Online LC-MS-NMR Sy
Training of Equipment	 GC-MS and LC-MS to for pharmaceutical ar 	raining course through nd biotechnology	manpower training program	
Equipment	 Solid Phase Extraction- Mass Spectrometer Sy Online Liquid Chromato Spectroscopy System 1 700 MHz High Resoluti Spectroscopy (HR-MA 500 MHz Nuclear Magr Gas Chromatograph-M Triple Quadrupole Liquid Ultra-Performance Liqu (UPLC QTOF MS) Liquid Chromatograph/ Two Dimensional Gas C (2D GC-TOF MS) 	800 MHz Nuclear Magne stem (SPE-800 MHz NM ygraph-Mass Spectromet Online LC-MS-NMR Sys or-Magic Angle Spinning S NMR) netic Resonance Spectror lass Spectroscopy (GC-N Chromatograph-Tandem N id Chromatograph-Time of Capillary Electrophoresis- Chromatograph-Time of F	tic Resonance Spectroscopy- R-MS System) er-Nuclear Magnetic Resonance tem) Nuclear Magnetic Resonance meter(500 MHz NMR) IS) Mass Spectrometer (TQ LC/MS/MS) of Flight Mass Spectrometer Mass Spectrometer (LC/CE-MS) ight Mass Spectrometer	UPLC-QTOF MS
	To Be Installed • Ultra-Low Voltage Field	d Emission Scanning Ele	ectron Microscopy	SPE-800 MHz NMB-M



Biomarker discovery flow of myocardial infarction using serum metabolite profiling based on LC-MS





Environmental & Material Sciences

We have built up world-class infrastructures for material sciences, nano-surface researches, environmental and earth sciences, and carried out domestic and international collaborations using national large-scale equipment. Our mission further extends to the analytical services and national projects, which are relevant to the resolution of social issues, such as radioactivity in the living environments and food safety. In addition, based on our expertise and analytical facilities, we actively provide technical support to the material and component industries.



Geochronology Research

In order to understand the timing of the evolutional and environmental changes of Earth, we develop dating techniques and perform collaboratory researches, using various equipment for luminescence and radiogenic isotope dating, including Sensitive High Resolution Ion Microprobe (SHRIMP). (Ochang Headquarters)

Main Research Activity

- The Silurian-Devonian magmatism recorded in detrital zircons from the Andong area, northeastern Yeongnam Massif, Korea
- · Application of isotopic composition of human bones to archaeology Investigations on rare earth element mineralization in the northwestern Okcheon Metamorphic Belt, Korea
- Investigations on luminescence dating of dolmens

Representative Research Case

Investigations on rare earth element mineralization in the northwestern Okcheon Metamorphic Belt, Korea

The mechanism of rare earth element mineralization in the NW Okcheon Belt was first revealed by SHRIMP U-Pb dating and various geochemical analysis.

Major Achievements

Achievements		
Publications 19 (SCI 13)	Presentations Domestic 26 International 1	
 Analysis of oxygen isotopes using SHRIMP OSL dating of palaeolithic sediments using single qi ⁴⁰Ar-³⁹Ar age determination for single grains using mugas mass spectrometer Correction of spike contribution for strontium isotop Thermal Ionization Mass Spectrometry (TIMS) 		
Development of n geochemical anal Exploration and de	 Development of micro-sampling instrument for high geochemical analysis Exploration and development technology of domestic 	
The 1st Internation The 2nd SIMS Sch	al Geochronology School nool	
 Sensitive High Resolution Secondary Ion Mass Spe Thermal Ionization Mass Spectrometer Static Vacuum Mass Spectrometer Optically Stimulated Luminescence Measurement S Laser Ablation Multicollector Inductively Coupled Plate 		
	Achievements Publications 19 (SCI 13) Analysis of oxyge OSL dating of pal 40Ar-39Ar age dete gas mass spectror Correction of spik Thermal lonization Development of n geochemical anal Exploration and de The 1st Internation The 2nd SIMS Scr Sensitive High Rese Thermal lonization Static Vacuum Mas Optically Stimulatee Laser Ablation Mult	





SHRIMP dating on Zircon from REE ore deposits in

ANALYSIS SERVICE

80 Users

141 Cases

1.767 Samples

.



SHRIMP

NW Okcheon Belt



Analysis of SHRIMP



Laser Ablation Multi-Collector Inductively Coupled Plasma Mass Spectrometer

uartz grains ulti-collector noble

pic measurement by

resolution dating and

c rare metal resources

m a Mass Spectrometer

Environmental Monitoring and Research

ANALYSIS SERVICE

1,376 Cases 14.487 Samples 622 Users

Environmental Monitoring & Research Group develops better ways of enhancing inorganic analysis, such as elemental analysis, isotope analysis, and natural radioactivity measurement. (Ochang Headquarters)

Main Research Activity

- · Planning Studies on the establishment of Center for Environmental Forensic Science
- · Discovery of ambient aerosol effects on total environmental pollution
- Preliminary study of presence of radionuclides in sludge from conventional drinking water treatment plants
- · Development of analytical technique, analytical support, and joint research and development



Discovery of ambient aerosol effects on total environmental pollution

The physiochemical characteristics of fine and coarse aerosol particles were studied in consecutive cold seasons of autumn and winter using various analytical techniques. Higher acidic components in fine particles could contribute acidification of soil that facilitates the mobility of heavy metals into groundwater environments.

Major Achievements

Category	Achievements		
Research Result	Publications 12 (SCI 11)	Presentations Domestic 23 International 4	Patents Application 3 Registration 2
Analytical Methods	 Habitat identificatio Comparison of acid glass bead digestid Analysis of nitrogen is Cu and Zn isotopic r Rapid gamma-ray s Determination of ra radio-frequency glo Determination of urar 	n using geochemical signa d dissolution and NH4F dea on for trace elements analy- sotopic composition of amma measurement using MC-ICP spectrometry of natural rad re earth elements in geolog w discharge mass spectro nium in ground water and soil	tures in fish otolith composition and low dilution sis in geological samples nium -MS ionuclides in soil gical samples with meter by ICP-MS
Projects	 CO₂ monitoring for Preliminary study o conventional drinkii CO₂ evasion from the Distribution and mo in biochar-containir Development of wat emergency assistant 	the leakage of CO ₂ in CO ₂ f presence of radionuclides ng water treatment plants polar ice sheet: carbon-clim ability of radioactive cesium ag soil environments er security technology for r ce (Especially for Rivers an	storage sites s in sludge from ate feedback n and iodine adioactive exposure d Dams)
Training of Equipment	Short course for ICF	P-AES/MS, XRF, and GD-MS	3
Equipment	Environmental Radii Stable Isotope Ratio Glow Discharge Ma Element Analysis Ec ICP System	pactivity Measurement Syste Mass Spectrometer ss Spectrometer Juipment	em
	To Be Installed • Laser Ablation System	em	



Evaluation of total environmental pollution through SEM/XNI images, and analyses of composition and structures for aerosols at cold seasons

Nano-Bio Electron Microscopy Research

Nano-bio Electron Microscopy Group carries out development of convergence imaging techniques using advanced electron microscopes, and aims to promote research support and multi-national collaborations though structural analysis of nano structures and the development of research equipment. (Daedeok Headquarters)

Main Research Activity

- · Development of state-of-the-art nano-bio core equipment and devices
- · Development of customized analytical techniques for advanced structure/function of nano materials
- Establishment of analytical technology for nano-biomedical convergence imaging
- · Collaboration with industries, universities and international research institutes

Representative Research Case

Development of SEM-TKD analytical method for the investigation of nano oxide and ultra-fine metal grain texture

Texture analysis of nano oxide and ultra-fine metal grain using conventional transmission electron microscope imaging and electron back scattered diffraction is known to be very challenging. Scanning Electron Microscope Transmission Kikuchi Diffraction (SEM-TKD) was effectively employed for such analysis and the technique is expected to contribute greatly to nano scale crystallographic structure research.

Major Achievements

	Category	Achievements	
	Research ResultPu 45Analytical Methods• A	Publications 45 (SCI 43)	Presentations Domestic 31 International 5
	Analytical Methods	Advanced 3D tomogra	phy analysis using UC-EF-TE
Ρ	Projects	Development of table top transmission electron mic Development of Nano-bio convergence SEM/STEM Structure degradation analysis and durability enhancement	
	Training of Equipment	6 cases of Youth educat	tion and junior doctor equipme
Equipment		High Voltage Electron Microscope, HVEM UC-Energy Filter-Transmission Electron Microscope, UC Field Emission-Transmission Electron Microscope, FE-TE 500 MHz Nuclear Magnetic Resonance Spectrometer, 50 UHA Field Emission-Scanning Electron Microscope, UH Multi-Purpose X-Ray Diffractometer, MP-XRD Focused Ion Beam, FIB Electron Probe Micro-Analyzer, EPMA	
		To Be Installed Low Voltage Transmission Electron Microscope 	

Glow Discharge Mass Spectrometer

ANALYSIS SERVICE

703 Cases 317 Users

. 3.447 Samples

(Left) TEM image of Al2O3, Cr2O3 nano-oxide (Middle) Reliability, phase, crystal orientation map obtained using TEM ASTAR (0.3° nano beam precession) (Right) Image quality map and phase map from simultaneous TDK & EDS, and TKD orientation map in combination with image guality map

Patents Application 5 Registration 3

croscope l core equipment ent research, 4 others

ent trainings

-EF-TEM FM 500 MHz NMR HA FE-SEM



UC-Energy Filtered Transmission Electron Microscope



Ultra-High Analytical Scanning Electron Microscope



Multi-Purpose X-ray Diffractometer

Advanced Nano-Surface Research

ANALYSIS SERVICE

. 314 Cases 191 Users

Our research field is development of the surface and interface analysis for future electronics, environmental materials and bio fusion using in-situ nanoanalytic system. (Daedeok Headquarters)

Main Research Activity

- · Leading low-dimensional new materials research using multidisciplinary in-situ analytical system
- Research of materials and devices of 2D atomic layered black phosphorus
- · Developing new analytical methods, supporting professional analysis and performing collaborated research based on high-tech instruments
- The development of eco-efficiency, low cost photo-catalytic materials

Representative Research Case

Stable semiconductor black phosphorus (BP) @titanium dioxide (TiO2) hybrid photocatalysts We report on robust BP@TiO₂ hybrid photocatalysts offering enhanced photocatalytic performance under UV/Visible light irradiation in environmental and biomedical fields, with negligible affected on temperature and pH conditions, as compared with MoS₂@TiO₂ prepared by the identical synthesis method.

Suggested schematics of photocatalytic mechanism for BP@TiO2 hybrid photocatalyst under visible-light irradiation.

Major Achievements

Category	Achievements			
Research Result	Publications 27 (SCI 27)	Presentations Domestic 10	Patents Application 3 Registration 2	Start Start
Analytical Methods	The analytical method materials using XPS The structural analysis	d for the chemical stoic s for the low-dimensiona	hiometry on the insulating I nano-material for use in KPM	
Projects	The development of m nanotechnology and n Next imaging system Zn-Mg and Zn-Free Al-	nulti-disciplinary in-situ a related science : NIS Mg type coating steel she	nalytical system for ets	NAP-XPS
Training of Equipment	SpectroNanoscopy W Surface Analysis Symp Korea Physics Society Korea Vacuum Society	orkshop posium v Conference v Conference		
Equipment	Low Energy Electron M Ambient Pressure X-Ra UHV Scanning Probe N Chemical Vapor Depos DC/RF Ion Sputtering S	licroscopy/PhotoEmissior ay Photoelectron Spectros /licroscopy ition System	n Electron Microscopy scopy	LEEM/PEEN
	To Be Installed Angle-Resolved Ultray 	violet Photoelectron Spe	ctroscopy	

UHV-SPM

Environment Risk & Welfare Research

We focused on the development of precede management protocols for the surveillance of hazardous chemical substances by developing the method to monitor hazardous materials and their effect on human and ecosystems. (Seoul Center)

Main Research Activity

- · Development of characterization and monitoring protocols of hazardous chemicals for the environmental regulatory purposes including toxic chemicals such as fluorine and sulfuric acid
- · Development of a protocol for environmental CCS monitoring
- Construction of omics data to monitor environment and hazardous substance related diseases

Representative Research Case

Strategies for overcoming limitations associated with fluorine determination in solid materials by conventional wavelength dispersive X-ray fluorescence spectrometry Potential ways to avoid limitations and improve analytical sensitivity in the determination of fluorine (F) in solid materials using Wavelength Dispersive X-Ray Fluorescence (WDXRF) spectrometry were investigated. WDXRF technique can be successfully used to assess the F content in solid materials by following the strategies proposed in this study.

Major Achievements

	Category	Achievements	ents	
	Research Result	Publications 11 (SCI 8)	Presentations Domestic 8 International 18	
	Analytical Methods	 Determination fluorine i dispersive X-ray fluores Metallothionein analysis using HPLC-ICP-MS Analysis of the useful c Optimization of simulta HPLC and LC-MS 	n solid materials by conventi scence spectrometry in solid in silver-exposed common ca omponent in natural textile b neous analysis of water-solu	
Project	Projects	 Development of preceder hazardous chemical sub Development of a protocent Study on the marine environment 	e management protocols for the stances in soil and groundwat ocol for environmental CCS n ronmental monitoring and marin	
	Training of Equipment	Molecular interaction an	alysis using SPR instrument	
Equipment	 Inductively Coupled Plasma-Mass Spectrometer Inductively Coupled Plasma-Atomic Emission Spectrome High Resolution Gas Chromatography/Mass Spectrometer High Resolution GC/TOF Mass Spectrometer TSQ-LC/MS • MALDI-TOF/TOF MS 			
		To Be Installed • High Resolution LC/GC- • IR-MASS (Isotope Ratio	-MS Mass Spectrometer)	



ANALYSIS SERVICE

357 Users

832 Cases 6.633 Samples



Calibration curve with standard samples prepared using 9:1 method (sample: PVA = 3.6 g : 0.4 g) during F determination using conventional WDXRF spectrometry (this study; open circles) and that previously reported by An et al. [17] (closed circles)

Patents Application 2

tional wavelength materials arp (Cyprinus carpio)

by HR-GC/TOF ble vitamins using

the surveillance of monitoring ne biofouling at pilot plant



UPLC-Q/TOF Mass Spectrometer



High resolution Gas Chromatography/Mass Spectrometry



Wavelength Dispersive X-ray Fluorescence Spectrometer

neter etry

Molecular Materials Research

ANALYSIS SERVICE

2.029 Cases 9.778 Samples 570 Users

Research for the green energy storage materials, such as improving lithium ion secondary batteries, examination of the mechanism, and modification of the present cathode/anode problems by using the surface reforming and nano-scale materials synthesis technology. (Busan Center)

Main Research Activity

- Development of the anode materials for the secondary batteries by applying the nano-scale synthesis technology
- Securing the volumetric expansion controlling technology of the battery materials
- Improving the lifetime and efficiency of the materials
- Improving the performance of the cathode materials through surface reforming
- Improving the performance of battery sealing AI surface reforming

Representative Research Case

Securing the conductivity of Li secondary batteries and the volumetric expansion control technology, and improvement of tensile force of the AI materials

- Suggest the nano-scale materials synthesis technologies for high-capacity anode materials by modifying the cycle characteristics of charge/discharge and securing the conductivity of Li secondary battery materials
- · Suggest the stability of the secondary batteries by improving the metal/resin tensile force

Major Achievements

Category	Achievements	
Research Result	Publications 26 (SCI 26)	Patents Registration 1
Analytical Methods	 Surface treatment and analy plastic-metal The study of structural chang BaTiO₃ nanoparticles prepare The analysis method for Co o X-ray Photoelectron Spectror 	isis for improvement of tensile strength of les in the synthesis conditions of ed by the solvothermal method exidation state in LiCoO ₂ thin films using meter as a function of temperature
Projects	 Research Infra project of high-te Characterization and develo by atomic layer deposition Plant response assessment on environmental changes Analytical method developmen by using spin-on-coating meth A study on recovery and separa from end of life vehicle Development of a vaporizer sys air-conditioning Development of a manufacturin to offshore plant 	achnology materials components for small business pment of Ru and Ruo2 thin film and technology development based t for impurity distribution of SiO2 film deposited ation of copper and nickel with the plated ABS stem of the plasma coater for refrigeration and ng process and analysis for buoyancy materials
Training of Equipment	Youth Education Support Pro The 2nd SIMS school	grams with Scientific Instruments (25 programs)
Equipment	Nano Secondary Ion Mass Spe Secondary Ion Mass Spectrom Angle-Resolved X-ray Photoele Time of Flight Secondary Ion M High Resolution Scanning Elec	ectrometer neter ectron Spectrometer 1ass Spectrometry tron Microscope
	To Be Installed	

Secondary Ion Mass Spectrometer

(A) Chemical structure of AAO surface-treated AI for tensile force improvement, (B) Composition analysis with the depth (C) Synthesis result of nanomaterials to improve characteristics of electrical conductivity and the charge-discharge of Li secondary battery anode electrode material

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Electron Microscope



electron Spectroscopy



dary Ion Mass Spectroscopy

Functional Materials Research

Characteristic analysis and developments of molecular sensing materials, Xray metrology science, and initiative actions for advanced nano and molecular convergence imaging laboratory are carried out to outperform others toward advanced functional materials analysis research center. (Daegu Center)

Main Research Activity

- · Research supports for industries, enterprises, and universities in Daegu-Gyeongbuk through operations of advanced analytical equipment
- · Developments of analytical methods for structure characteristic evaluations of nano convergence materials and technical transfers to enterprises
- · Research collaborations with domestic and international institutions for developments of molecular sensing materials and devices

Representative Research Case

New platform for advanced nanodevice functions

We successfully accomplished the quantum characteristics imaging of inter-nanorods energy transfer rate using a Time-Resolved Fluorescence Confocal Microscope. Nowadays, semiconductor nanoparticles are key building blocks for the applications of high-brightness display and solar cell industries. This finding enables a base-stone for greatly enhancing nanodevice performance based on the observed direct quantum characteristics imaging technique between nanosystems.

Major Achievements

Category	Achievements	
Research Result	Publications 19 (SCI 18)	Presentations Domestic 10 International 1
Analytical Methods	 Fluorescence lifetime and lifetime imaging of metal Efficiency evaluation of metal-induced fluorescence e Lithium NMR analysis of nano-structured olivine-typ for rechargeable batteries Sodium NMR analysis of the local structure of oxyn 	
Projects	 Installation and operation medium enterprises in Da A study for time-and sp on plasmonic functional ²H{¹⁹F} REDOR NMR spec anticancer drugs 	of customized support system egu ace-resolved molecular ima nanoplatforms ctroscopy for the 3D bioactive s
Training of Equipment	Equipment education for Short training courses for Youth education support	r users in small and medium e r technical transfer of analytica t programs with scientific instr
Equipment	X-ray Diffractometer (Hig High Resolution Mass S High Resolution Field En 200 kV Field Emission Tr Focused Ion Beam X-Ray Fluorescence Spe Time-Resolved Fluoresc FT-UV-VIS-IR Spectrosc UV/VIS/NIR Optical Spe	th Resolution, Multi-purpose, pectrometer nission Scanning Electron Mic ansmission Electron Microsco ectrometer ence Confocal Microscope opic Imaging Microscope ctrophotometer
	To Be Installed	

High Resolution 2-Dimensional X-Ray Diffractomete





ANALYSIS SERVICE

488 | Isers

2.614 Cases

14.028 Samples

TEM images of CdS semiconductor nanorod assembly

Time-resolved fluorescence image

Patents Application 1

oxide thin films enhancement pe cathode materials

itride-type perovskites

ns for small and

aging based

structure of epothilone

enterprises (2 programs) al methods (3 programs) ruments (13 programs)

, Multi-Function)

croscope cope



Time-Resolved Fluorescence Confocal Microscope (FLIM)



Multi-Function X-ray Diffractometer (MF-XRD)



200 kV Field Emission Transmission Electron Microscope (FE-TEM)

Carbon-based Materials Research

Jeoniu center is performing research support and collaborations to improve nanoscience and nanotechnology on carbon based materials. (Jeonju Center)

Main Research Activity

- · Jeonju center acquired the ISO 9001 quality management system certification and provide reliable analysis of data for creative economy development
- Researches on physical properties of nanomaterials and carbon composites
- · Collaborative research and analysis based on leading research equipment

Representative Research Case

Strain effect on the role of thermal heating and electric field in VO₂ nanobeams

The VO₂ nanostructures can also provide new opportunities to explore, understand, and ultimately engineer MIT properties for applications of novel functional devices. Importantly, the MIT properties of the VO₂ nanostructures are significantly affected by stoichiometry, doping, size effect, defects, and in particular, strain. Here, we report the effect of substrate-mediated strain on the correlative role of thermal heating and electric field on the MIT in the VO₂ nanobeams by altering the strength of the substrate attachment.



ANALYSIS SERVICE

300 Users

736 Cases

5.685 Samples

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Schematic illustration showing two different types of transferring processes of VO2 nanobeams onto the SiO₂/Si substrate

Energy Materials Research

We investigate diverse materials that can improve the utilization efficiency of energy resources to resolve global energy and environmental issues. (Suncheon Center)

Main Research Activity

- · Materials design, synthesis and analysis of electrode materials for non-lithium rechargeable batteries
- · Exploring electrochemical catalysts for reducing the atmospheric carbon dioxide level
- · Cooperative research analysis using the state-of-the-art equipment

Representative Research Case

Strategies to control the polymorphism of electrode materials for rechargeable batteries The energy density of rechargeable batteries can be significantly influenced by altering the crystal structure of electrode materials, suggesting that the control of polymorphism is an efficient way to improve cell properties; for such a control of polymorphism, crystal defects such as a vacancy can play an important role.

Major Achievements

Category	Achievements			
Research Result	Publications 20 (SCI 18)	Presentations Domestic 39	Patents Application 4 Registration 3	
Analytical Methods	 Analysis method for the correlative role between strain and thermal/electric field energy on a metal-insulator transition Analysis method for heterostructure of diamond like carbon nanowires Molecular weight analysis of the oil pitch component eluted by several volatile solvent Development of weathering environment margarite analysis by EPMA study SEM image analysis with charge-up suppress scanning (CSS) 			
Projects	 Development of anode materials for Li-Ion secondary batteries with high stability Development of analysis and synthesis for functional construction materials of carbon-based industry ISO 9001 qualified analysis center of carbon composite materials for support of small and medium businesses A study on property and mechanism of phase change memory device using in-situ TEM A development of in-situ multi-disciplinary characterization system for oxide electronics using ultrafast phase transitions Observation and control of physical properties in single-crystalline VO2 nanostructures by electron beam irradiation 			
Equipment	•Cs-TEM •FE-EF-TEM •UHR FE-SEM •HR FE-SEM •FE-SEM •PSA system •AFM system			
	To Be Installed			

ed Transmission Electron Microscope -TEM)



Resolution Field Emission Scanning croscope (UHR FE-SEM)



Micro Raman spectroscopy system (µ-Raman)

Major Achievements

Category	Achievements	
Research Result	Publications 7 (SCI 7)	Presentations International 1
Analytical Methods	Computational design CO2 to methanol Computational analysi	of heterogeneous catalyst for s of magnetic properties of Fe
Projects	Development of highly rechargeable batteries	stable anode materials for Lit
Training of Equipment	X-science education pr	ogram
Equipment	 Field Emission Transmi Field Emission Scannin X-Ray Diffractometer Thermogravimetric Ana Differential Scanning Car 	ssion Electron Microscopy g Electron Microscopy Ilysis alorimetry



ANALYSIS SERVICE

394 Cases 72 Users

. **2.263** Samples

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Discharge capacity comparison between rose and blue polymorphs, where the rose form has a higher energy density by more than 40 %

Patents Registration 3

electroreduction of

-MOF-74

thium-lon



Linux Cluster



X-Ray Diffractometer



Thermogravimetric Analyzer

Advanced Material Science Research

The purpose of the advanced materials research is finding a relationship between crystalline structure and physical properties to investigate new materials for energy storage devices such as Li-ion battery system. (Gangneung Center)

Main Research Activity

- · Crystalline structure analysis of thin film Li-ion battery materials during lithiation and de-lithiation process
- Realize a Li-ion battery system with advanced charging-discharging properties using 3D nanostructures of inverse opal
- Investigate a new analysis technique using new facilities and analysis support and collaborations with expertise

Representative Research Case

In operando strain measurement of bi-continuous silicon coated Ni inverse opal anode for Li-ion batteries

The researches on improving an endurance of Si anode materials which have high energy density have been done via an analyzing a relationship between stress and strain evolutions during lithiation and de-lithiation. We suggest these experimental results can be applied to commercialize a Si anode material for Li-ion battery system.



ANALYSIS SERVICE

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1.443 Samples

196 Cases

77 Users

The schematic of crystalline structure analysis of Si Li-ion battery using X-ray diffraction technique based on synchrotron

Major Achievements

Category	Achievements	
Research Result	Publications Presentations 7 (SCI 6) Domestic 2 International 4	
Analytical Methods	 Fluorescence lifetime and lifetime imaging of metal oxide thin films In-situ XRD measurement during Li lithiation and de-lithiation for Li-ion battery system 	Multi-Purpose X-Ray Diffractometer (MP-XRD)
Projects	 Installation and operation of customized support systems for small and medium enterprises in Gangneung Study on development of Gangneung center 	
Training of Equipment	 Equipment education for users in small and medium enterprise Short training courses for technical transfer of analytical methods X-science education program 	Field Emission Scanning Electron Microscope (FE-SEM)
Equipment	 Field Emission Transmission Electron Microscopy Field Emission Scanning Electron Microscopy X-Ray Diffractometer Wavelength Dispersive X-Ray Fluorescence Spectrometer System 	

Field Emission Transmission Electron Microscope (FE-TEM)

Functional Interface Science

Characterization of interfacial properties of energy and environmental materials/system has been carried out using magnetic resonance spectroscopy such as solid state NMR and EPR spectroscopies in order to improve their performance. (Western Seoul Center)

Main Research Activity

- · Characterization on behavior of proton and water in Nafion polymer electrolyte membrane
- · Reactivity studies of metal-amyloid beta peptides/structural investigation of biomimetic water oxidation catalysts
- Development of catalytic nanomaterials toward environmental remediation such as oil/water separation, waste water treatment and heavy metal removal

Representative Research Case

Silica nanocapsules for co-treatment of oil/water separation and water purification Synthesis of silica micelles (hydrophilic core@amphiprotic shell) and their multiple applications such as oil/water separation and pollutant purification, and an ultrahigh loading capacity of enzymes with significant stability.

Major Achievements

Category	Achievements		
Research Result	Publications 11 (SCI 11)	Presentations Domestic 14 International 11	1
Analytical Methods	Measurement of powde Measurement of dynam Overhauser dynamic nu	er resistivity of graphene flak nics of protons and water in uclear polarization	F
Projects	 Environmental remediation nanostructures Degree and research or on advanced functional Development and applit for investigation of election Multifrequency/multited materials 	tion using multi-dimensional enter for magnetic resonance I materials ication of nuclear magnetic r trochemical reaction and ior chnique EPR application for l	e Te
Training of Equipment	Fundamental operation Fundamental operation	techniques of liquid state NM techniques of solid state NMF	F
Equipment	 Single Crystal X-ray Diffra CW/Pulse EPR System: > 600 MHz Solid State NMI 400 MHz Solid State NMI 200 MHz Solid State NMI 500 MHz FT-NMR Spectra 	ctometer System (-band(CW), X/Q-band(CW/Pu R Spectrometer R Spectrometers R Spectrometer ometer	ıł



ANALYSIS SERVICE

483 Cases 182 Users

• • • • • • • • • • • • 3.912 Samples



Schematic structure of silica micelles composed with hydrophilic core@amphiprotic shell



Cover picture of Adv. Funct. Mater, 2015, 25 (28)

Patents Application 2

polymer electrolyte using

hierarchical

spectroscopy

esonance techniques nic behavior bio/energy related

R spectroscopy spectroscopy

lsed), W-band(CW/Pulsed)



400 MHz Solid State NMR



500 MHz Liquid State NMR

Scientific Instrumentation

A roadmap for analytical technology and equipment development is established to promote research equipment projects within Korea and localize high-priced imported equipment. KBSI is also formulating plants for promoting research equipment business through industry-academic cooperation and network reinforcement. For securement of core technologies, a variety of domestic research equipment with highest demands and enough capabilities are under development; which include NMR using cryogen-free high-temperature superconducting magnet, low end benchtop TEM, and ion cluster beam TOF-SIMS.



Instrumentation Development Support

To maintain the performance of large-scale research equipment in industries, universities, research institutes, the maintenance and the design of research equipment is supported, which encourages the utilization of national research equipment. (Daedeok Headquarters)

Main Supporting Activity

- · Technical assistance for the maintenance and resolve of complaints of all research equipment
- Support for the design and production for the development and modification of all research equipment
- · Support for utilization of all electronic instrumentation and mechanical fabricating equipment

Representative Supporting Case

Medical center of research equipment for small and medium sized enterprises (SMEs) support

Professional engineers in the medical center of research equipment have been taken charge of the maintenance of state-of-the-art research equipment of KBSI. After the medical center is launched to support for research equipment in SMEs, the medical center accomplishes troubleshooting for ≥200 equipment of KBSI and for ≥20 equipment of SMEs. --> more than 200 equipments of KBSI and 20 equipments of SMEs.

Major Achievements

Category	Achievements	
Maintenance Service	Service on KBSI Repair 144 items, Installation 10 items, Machining 70 items	Service on SMEs Repair 20 items
Analytical Methods	A patent to improve the	e performance of the coater o
Projects	The maintenance of stat The support for the dev The improvement for the	e-of-the-art research equipme velopment of research equipme life-cycle management of resear
Training of Equipment	Training of inductively and high-performance	coupled plasma mass spec e liquid chromatography (HF
Equipment	 Oscilloscope (500 MHz Spectrum Analyzer (PS Network Analyzer (R&S 5-Axis CNC Machine (t 3-D Coordinate Measu 	z, 11402A) ;AE4443A) } ZVL) HSC600/5) ring (CONTURA-G2)
	To Be Installed • Ultra-Precision Polishir	ng Machine

TECHNICAL SERVICE

224 Items of Services 20 Items of Services 4 HUNDRED MILLION Result of Income



The introduction of the medical center for research equipment in Korea Basic Science Institute (KBSI)



n a SEM.

ent nent rch equipment

ctrometry (ICP-MS) PLC)

The troubleshooting for the probe of Solid-State Nuclear Magnetic Resonance



The diagnostic for the E-beam gun of Scanning Electron Microscope



The troubleshooting for the Ultra-High Pressure Liquefier

Optical Instrumentation Development

ANALYSIS SERVICE

20 Cases 115 Samples 17 Users

Optical Instrumentation Development team researches on next-generation optical research instruments like microscopes, spectroscopes, space observing telescopes and satellite optics through ultra-precision machining and polishing process on aspherical/freeform optical surfaces with nanometer figure error and introduction of state-of-the-art fabrication and inspection machines. (Daedeok Headquarters)

Main Research Activity

- · Development of airborne payloads for remote sensing of coastal area
- · Development of ultra-precision machining process for space cryogenic infrared optics of 30 cm diameter
- · Development of photothermal microscope for detection and imaging of single nanoparticles
- · Development of multi-modal microscopic system for imaging and analysis of the three-dimensional cell cultures

Representative Research Case

Development of airborne payloads for remote sensing of coastal area

The EM model of an aerospace payload, specialized in remote sensing of domestic coastal area, was designed and developed for monitoring the marine accidents and ecosystem from the spectral information like water temperature and color variation.

Major Achievements

Category	Achievements		
Research Result	Publications 17 (SCI 14)	Presentations Domestic 14 International 12	Patents Application 10 Registration 10
Analytical Methods	 High resolution th Highly sensitive flu High-speed optic: Development in u Optical alignment surface 	ermal analysis method for s lorescence imaging of biolog al coherence imaging ltra-precision machining pro method for inspection of fig	emiconductor devices jical cells ocess of off-axis mirror guring error of an aspheric
Projects	Development of high Development of h Development of h Development of cor Virtuous Eco-BIZ ci	n resolution thermal analysis sys igh-resolution infrared optic h-speed cooled deformable m re technology for the infrared s rcle construction of Daejeon m	tem for semiconductor devices al system and LIT module irror pectral imaging payload etalworking industry
Training of Equipment	Basic training of ul Training of ultra-pre	tra-precision machining ecision machining & measurin	g
Equipment	Ultra-precision Fre High-precision 3-a Ultrahigh Accurate Non-contact 3D su Non-contact optic Sub-aperture stitcl Ultra-precision Pol	eform Generator (Freeform 7 ixis SPDTM (Nanotech 450 L 2 3D profilometer (UA3P) urface profiler (CCI-Optics) s roughness profiler (NT2000 hing interferometer (ASI(Q)) lishing Machine (UPPM600)	00A) IPL))
	To Be Installed • MBE Surface Finis	hing Machine (Q-flex300)	

Optical Surface Profiler



Airborne TMA fore optics for remote sensing of coastal area; Optical layout (left), Optomechanical module (right)

Spin Engineering Physics Research

Establishing a high magnetic field environment using Low Temperature Superconductor (LTS) and High Temperature Superconductor (HTS) and understanding new physical phenomena of the strongly correlated electron system by measuring material properties from low temperature (1.5 K) to high temperature (800 K) and distributing to the development of new functional materials. (Daedeok Headquarters)

Main Research Activity

- A study of material properties by measuring resistivity, specific heat, ac magnetic susceptibility using low temperature superconducting physical property measurement system
- · A study of magnetic properties using magnetic property measurement system
- · A development of the world first cryogen-free NMR using high temperature superconductor
- · A method development through state-of-the-art equipment, specialized analysis support and collaboration

Representative Research Case

Suggestion of the accurate measurement of spin hall angle in spin device We suggested a precise method for spin hall angle measurement by the FMR experiment of the layered Ta/CoFeB structure varying Ta thickness using home-made TE011 Resonator. We developed a new technique for detracting spin-rectified effect.

Major Achievements

Category	Achievements		
Research Result	Publications 9 (SCI 9)	Presentations Domestic 10 International 2	
Analytical Methods	Damping constant me Cryogenic temperature	asurement technique sensor calibration techniqu	е
Projects	Development of spin d Development of the lo Spin-orbit measureme Low temperature Vector Cryogen-free high temp Low temperature probe	evice measurement techniqu w power half-metallic spin nt technique Field SPM erature superconductor NMR station development	le dev
Training of Equipment	Magnet and magnetic : Extreme low temperatu Gold nanoparticle : prir Thermal transport tech	field re with liquid nitrogen ciple and application nique	
Equipment	 16 T Physical Property N Magnetic Property Mea Scanning Probe Micross Cryogenic Probe Station High Magnetic Field System 	Neasurement System surement System cope n tem	
	To Be Installed • High Field Scanning Pr	obe Microscope	



ANALYSIS SERVICE

81 Cases 50 Users

. 485 Samples



Schematic illustration of the measurements



Measured Anomalous Hall Voltage

We reduced the microwave effect by precise control the sample position using home-made TE011 cylindrical cavity to increase the experimental precision. We could rearrange the AHE into Inverse Spin Hall term and spin-rectified term through resorting to formula

Patents Application 5 Registration 6

vice



7 T Magnetic Property Measurement System



Cryo-Probe Station



16 T Physical Property Measurement System

Mass Spectrometry and Advanced Instrumentation Research

ANALYSIS SERVICE

. 87 Cases 404 Samples 69 Users

Mass spectrometry and advanced instrumentation research is creative allied research field to develop the advanced mass analysis research equipment and to establish performance evaluation and standards of domestic research equipment for industry's development. (Ochang Headquarters)

Main Research Activity

- · Ion cluster beam TOF-SIMS equipment development
- High sensitive portable mass spectrometer development
- · Development of ion selection by ion mobility in asymmetric E-field
- · Practical support and performance evaluation of domestic research equipment
- · Development of key component technology for mass spectrometer

Representative Research Case

Development of portable mass spectrometer using cold electron ionization source

The third generation of ion trap with the cold electron ionization source was developed to downsize the portable mass spectrometer. The registered patent for the cold electron source can be applied in the actual field, which has low energy consumption, no heat to dissipate, no noise background, and precisely controlled electron beam duration and intensity.



Third-generation ion trap with cold electron source

Major Achievements

Category	Achievements		
Research Result	Publications 2 (SCI 2)	Presentations Domestic 12 International 5	Patents Application 2 Registration 9
Analytical Methods	Performance verific Performance verific ionization time-of-fl	cation of high performance ation of linear type matrix a ight mass spectrometer (M/	liquid chromatography ssisted laser desorption ALDI-TOF)
Projects	Development of ion of Performance evaluat High sensitive portab Development of ion se	cluster beam TOF-SIMS tion and practical support of ele mass spectrometer develo election by ion mobility in asym	domestic scientific instrument pment metric E-field
Equipment	Elemental Analyzer Orbitrap Mass Spec	strometer	
	To Be Installed Multi Chromatograp 	hy-Ultra High Sensitive Qua	antitation System

Multi Chromatography-Ultra High Sensitive Quantitation System

Ion Beam Research

A heavy ion accelerator employing the third generation 28 GHz superconducting electron cyclotron resonance (ECR) ion source has been developed for various ion beam application. The highly-charged ion beams with respect to various species are now supplied for the user in the field of extreme environmental materials (fusion/nuclear power, shipbuilding) and advance materials (semiconductor, energy device, sensors). (Busan Center)

Main Research Activity

- · Development of national heavy ion beam user facilities
- · Ion beam implantation using 28 GHz superconducting ion source
- · Cooperative research with extreme environmental materials, energy and advanced materials utilizing a heavy-ion beam
- · Development of key device for linear accelerator and high-frequency amplifier

Representative Research Case

Development and operation of 28 GHz ion source and linear accelerator system The research on optimum condition of heavy ion beam with respect to various species for stable operation of 28 GHz superconducting ECR ion source has been performed. Based on this study, ion implantation service has been started. For higher beam energy, linear accelerator system has been developed.

Major Achievements

Category	Achievements		
Research Result	Publications 13 (SCI 12)	Presentations Domestic 14 International 14	Patents Application 1 Registration 1
Analytical Methods	 ZnO nanorod doping effect with oxygen, nitrogen and hydrogen ion beam Electrical conductivity control mechanism of TFT using hydrogen ion beam P-type ZnO characteristics by oxygen, nitrogen and hydrogen ion beam implantation Surface modification of electrochemical sensors using ion beam implantation 		and hydrogen ion beam sing hydrogen ion beam I hydrogen ion beam ing ion beam implantation
Projects	Development of heavy-ion beam facilities using superconducting ECR ion so Development of wien filter for application of mass spectrometry		conducting ECR ion source spectrometry
Training of Equipment	 -200°C : Ultra-low temp Atoms and component: Particle accelerator and 	erature and superconductor introduction of accelerator its application for advanced	science and technology
Equipment	28 GHz Superconducting Beam Transport and Diag Radio Frequency Quadr.	g ECR Ion Source gnostic System upole Accelerator System	
	To Be Installed • Drift Tube Linear Accele • Neutron Generation Sys	rator	





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72 Samples

ANALYSIS SERVICE

12 Cases

9 Users

Ion beam spectra for Oxygen and xenon charge



28 GHz Superconducting ECR Ion Source



Sample Loading System for Ion Beam Implantation



Heavy Ion Accelerator System

Description of photograph | 2015 KBSI Science Image Contest Bronze Prize Winners' Works Full Moon, Hyun-joo Lee (Chungnam National University) Bio-TEM image of influenza virus (X 30,000)

LEADING RESEARCH EQUIPMENT

KBSI develops cutting edge analytical technology to extend capability of analytical services and develops high-tech research equipment and related elementary technology to secure national competitiveness.

KOREA BASIC SCIENCE INSTITUTE

ANNUAL REPORT 2015

- High Voltage Electron Microscope
- 15 T Fourier Transform Ion Cyclotron Resonance
- Mass Spectrometer
- High Field-Nuclear Magnetic Resonance
- High Resolution-Secondary Ion
 Mass Spectrometer
- Multi Disciplinary in-situ Analytical System
- Nano-Secondary Ion Mass Spectrometer
- Femtosecond Multi-Dimensional
- Laser Spectroscopic System

High Voltage Electron Microscope / HVEM

The High Voltage Electron Microscope (HVEM), which allows structural analysis at atomic-resolution, is operated as national co-utilization equipment in basic and applied sciences such as the structure analysis of new materials. 3D analysis of subcellular

Daedeok Headquarters

structures, and development of infinitesimal materials.



Characteristics of Equipment

- Observation of three-dimensiona (3D) atomic structure of materials by concurrently implementing its atomic resolution (0.12 nm) and high tilting function (± 60°)
- Chemical and electronic structure analysis with high voltage energy filtering system (HV-GIF) that can utilize the electron energy loss spectrum (EELS) with relatively higher collection ratio
- In-situ and Cryo-EM analysis with customized specimen holders



HRTEM images obtained at different temperatures for characterization of the crystallographic information and thermal stability of mGeTe-Bi2Te3(m=3-8) nanowires



Characterization of GBT nanowires

mGeTe·Bi₂Te₃ (m=3-8) nanowires applied for the phase-change random-access memory, which is considered to be promising for use in next-generation solid-stage flash memory devices, were characterized to be synthesized under optimum conditions. The advantages of HVEM with in-situ heating analysis were contributed to determine the structure/phase change and thermal stability characters for the first time in the world.

Major Achievements



Atomic structure analysis of the interface of thin film



3D analysis of subcellular structures



Real-time structure analysis



Structural analysis of functional protein

15 T Fourier Transform Ion Cyclotron Resonance Mass Spectrometer / 15 T FT-ICR MS

15 T Fourier Transform Ion Cyclotron Resonance Mass Spectrometer, which was developed through joint research with National High Magnetic Field Laboratory (NHMFL) in United States and Bruker Daltonics. Inc., has been installed and operated at Ochang headquarters since 2007. A new method of ultra-high-resolution mass spectrometry was developed for promotion of joint research and it is used for analysis of crude oil. organic acids, natural substances, metabolites, and environmental samples.



Ochang Headquarters

- Dual ion source : ESI/MALDI

Representative Research Case

- level by 15 T FT-ICR MS.

After oil spill accident from the Hebei Spirit near the ocean of Taean on December 7, 2007, the comparison of naturally weathered oil and artificially photodegraded oil at the molecular level by a combination of SARA fractionation and FT-ICR MS.

Major Achievements

The FT-ICR MS can be used to investigate the polar molecules in spilled oils. Weathered oils and photodegraded oils are compared at the molecular level using 15 T FT-ICR MS.



tion process.



• The world best mass resolution : > 10,000,000 Applicable methods : MALDI Imaging, APCI, APPI, LC/MS/MS · Various MS/MS techniques : CID, ECD, ETD, IS-CAD

Analysis of spilled oils and related pollutants using UHR MS

The FT-ICR MS coupled with SARA fractionations is improved technique for

complete characterization of chemical compounds in spilled oil at molecular level.

This technique was used to analyze the spilled oils and related pollutants.

· Spilled oils obtained from different weathering stages of the oil spill site and photo-degraded oils are separated by saturate, aromatic, resin, and asphaltene (SARA) fractionations. The compositions and abundance of compounds in spilled oil compared at the molecular



The molecular formula of pharmacologically active



Understanding of NOx effects on biogenic SOA formation is improved by comprehensive elemental composition determination of SOA with the ultra-high resolution 15 T FT-ICR MS. OM/OC ratios of SOA were slightly increased in the presence of NOx.



Low-abundance biomarker candidate TIMP1 was substances in a ginseng extract can be simultaneously identified from colorectal cancer patient's serum using determined using 15 T FT-ICR MS without any separa- MALDI-FTICR MS, demonstrating that ultrahigh-resolution MS can be powerful tool toward identifying and verifying potential protein biomarker candidates.

Characteristics of Equipment

High Field-Nuclear Magnetic Resonance / 900 MHz Cryogenic NMR

Ochang Headquarters



900 MHz Nuclear Magnetic Resonance Spectrometer is installed in Ochang headquar-

ters as the core equipment for researches in molecular structure determination and new



Characteristics of Equipment

- The cryoprobe with enhanced ¹H sensitivity (by a factor of 4) can reduce the experimental time up to 1/16.
- Protein Structural studies can be performed with 100 µM or lower concentration samples.
- Minimum mass for ¹³C experiment of natural products is about 100 µg.



HECADE spectrum of gargantulide A which is isolated from Streptomyces Sp. at 900 MHz NMR

Representative Research Case

Research on structure of antibiotics isolated from actinomyces

Gargantulide A, an extremely complex 52-membered macrolactone, was isolated from Streptomyces sp. A42983 and displayed moderate activity against MRSA. The planar structure of gargantulide A was determined using 2D NMR, and its stereochemistry was partially established on the basis of NOESY correlations, J-based configuration analysis.

Major Achievements



Research on protein structure





Research on natural product structure

Research on dynamics

High Resolution-Secondary Ion Mass Spectrometer / HR-SIMS Ochang Headquarters

High Resolution-Secondary Ionization Mass Spectrometer (HR-SIMS, model : SHRIMP-IIe/MC), which can measure the isotope ratio for microscopic areas of surface in solid materials, has been operated for researches on geotectonic age and surface analysis of trace isotope elements.



Characteristics of Equipment

- simultaneously

Representative Research Case

origin of Eoarchean environment.



Cathodoluminescence image and age of zircons from Isua sand (left) and probability diagrams for ages of zircons (right)

Major Achievements



U-Pb geochronology



In situ isotopic measurement of microtexture

· KBSI SHRIMP is the first high resolution secondary ion mass spectrometry in Korea, and has low detection limit (~1 ppm) with 10,000 mass resolution and 50% transmission. • Multi-collection system with charge-mode electrometers can measure Pu isotopes

The origin of the Itsaq gneiss complex of SW Greenland were revealed

Using internal funding inside KBSI, international joint research team with Korea-Australia-England was organized. Isua complex, SW Greenland, was investigated during field work and zircon grains was dated by high resolution secondary spectrometer (SHRIMP) for the age and







Reconstruction on geotectonic evolution and history





Isotopic ratios and age determination of meteorite

Multi Disciplinary in-situ **Analytical System**

Daedeok Headquarters

KBSI designed and developed the one-line in-situ multidisciplinary system that integrated multiple organic nano-substances and process equipment in ultra-vacuum condition. KBSI also established system for analyzing properties of functional organic and inorganic materials and evaluating basic properties of nanoelectro-materials.

Nano-Secondary Ion Mass Spectrometer / Nano-SIMS

Nano-Secondary Ion Mass Spectrometer (Nano-SIMS, model : Nano SIMS 50), which can perform the quantitative imaging process for the distribution of trace elements in materials, is operated as national co-utilization equipment in the high-tech material research field





Characteristics of Equipment

Representative Research Case

The new analytical method of OD radical effects on cell components using Nano-SIMS We investigate the possibility of the use of an isotope as a new method for the detection of OH radical interactions with biomolecules. OD radicals instead of OH radicals are generated through a plasma jet. E. coli are treated with a deuterated the non-thermal plasma jet and the location of deuterium is determined by means of Nano-SIMS. The Nano-SIMS image shows that deuterium is incorporated in both the cytoplasma and membrane, which are colocalized well with nitrogen and phosphorus atoms in E. coli .

Major Achievements





Element distribution analysis of plasma treated cell



Characteristics of Equipment

- Combination system of the process and the analysis which provides the fundamental information on basic science
- · Support nanotechnology and other complex science with qualified data and information on basic knowledge on the new-forthcoming materials for the future



Suggested schematics of photocatalytic mechanism for BP@TiO2 hybrid photocatalyst under visible-light irradiation

Representative Research Case

Stable semiconductor black phosphorus (BP) @titanium dioxide (TiO2) hybrid photocatalysts

A semiconductor black phosphorus (BP) is a derived cutting-edge post graphene contender for nanoelectrical application, because of its direct band gap nature. For the first time, we report on robust BP@TiO₂ hybrid photocatalysts offering enhanced photocatalytic performance under UV/Visible light irradiation in environmental and biomedical fields, with negligible affected on temperature and pH conditions, as compared with MoS₂@TiO₂ prepared by the identical synthesis method. Remarkably, in contrast to pure few layered BP, which, due to its intrinsic sensitivity to oxygen and humidity was readily dissolved after just several uses, the BP@TiO2 hybrid photocatalysts showed a ~92 % photocatalytic activity after 15 runs.

Major Achievements



The measurement of AFM, STM, KPFM images related Atomic scale ultrathin films growth (PE-ALD) signals such as tunneling current, force and force aradien



NAP-XPS analysis under pressure (up to 25 mbar) and humidity similar to those encountered in natural environments



The measurement of local work function and structure on material surface









(a) The schematics of a non-thermal plasma jet (NTPJ) device generating OH and OD radicals (b) ¹²C¹⁴N, ³¹P and ¹²CD nanoSIMS images from bacteria exposed to N2/D2O plasma generated from NTPJ device





- · World's best spatial resolution (50 nm) in Secondary Ion Mass Spectrometer
- · Multiple detection of impurity elements in the small area
- · High sensitivity imaging of light elements (including hydrogen)
- · Highly reproducible analysis of insulating samples

Element distribution analysis of energy materials



Research on inter-granular crack of steel used as atomic power reactor



Depth profile analysis of impurities in a small semiconductor pattern

Femtosecond

Multi-Dimensional

Laser Spectroscopic

Femtosecond Multi-dimensional Spectrometer, which enables real-time analysis of transient molecular events in the femtosecond time scale, is installed in Seoul Center and is utilized for a range of researches on ultrafast molecular dynamics in the fields of chemistry, biology, and material science.

Seoul Center

System



Characteristics of Equipment

- 2D vibrational and electronic spectroscopy in the infrared and visible frequency ranges
 Pump-probe transient absorption spectroscopy
- · Femtosecond time-resolved (50 fs) chiroptical spectroscopic measurement
- Fast structural dynamics of biomolecules using temperature-jump (T-jump) technique



(a) The Molecular structure of Zn naphthalocyanine
 (ZnNc) (b) Time-resolved 2D electronic spectra (c)
 Quantum coherence oscillations of the CP21 peaks
 (d) Fourier transform spectra of (c)

Representative Research Case

Investigation on the quantum coherence oscillation of photosynthetic light-harvesting analogue

The origin of coherent oscillations observed in two-dimensional (2D) electronic spectra of photosynthetic light-harvesting complex still remains an open question. The 2D electronic spectroscopic study of chlorophyll-like molecular monomer and aggregate revealed that such quantum beats are attributed to vibrational coherence. This study showed that there could be another yet different mechanism, which is apart from the previous explanation, to account for the high energy transfer efficiency of photosynthetic system.

Major Achievements



Femtosecond optical activity measurement of chiral molecule



Energy transfer dynamics of photosynthetic system



Real time measurement of chemical exchange (acidbase reaction, etc.)



Fast structural dynamics of biomolecules (protein, DNA)







Description of photograph |

2015 KBSI Science Image Contest Bronze Prize Winners' Works <Interstellar>, Doo-na Kim (Korea University of Technology and Education) Polarizing Optical Microscope (OM) image of YBCO Superconductor (X 500)

NATIONAL AGENDA-SOLVING SCIENCE RESEARCH

KBSI installs and operates national leading research equipment to develop new research areas of domestic and international research institutes such as realizing ideas of scientific innovation and solving issues of fundamental research.

KOREA BASIC SCIENCE INSTITUTE

ANNUAL REPORT 2015

Development of Analytical Technologies

- Standardized Technology for Discriminating
 the Geographical Origin
- Analytical Technology in Disaster Science
- Bio-imaging Technology for Early Disease Diagnosis
- Culture Property Preservation and Analysis Technology
- Analytical Techniques using Biochemical
 Forensic Biomarkers

Development of High-Tech Equipment

- Low End Tabletop Transmission Electron Microscope
- Cryogen-Free NMR System Using High-Temperature
 Superconducting Magnet
- Conduction-Cooled Cryogenic Crobestation
- Ion beam SIMS system
- Portable Mass Spectrometer
- Thermal Imaging Inspection Equipment for Stacked Semiconductor Chip

DEVELOPMENT OF ANALYTICAL TECHNOLOGIES

We are developing high-tech analytical technologies to resolve social problems that trigger global issues including diseases and disasters; and global issues such as environmental pollutions, energy, problems, and climate changes.



Standardized Technology for **Discriminating the Geographical Origin**

Environmental Monitoring and Research Team

Introduction

Development of the integrated analysis technology of discriminating the geographical origin of various agricultural foods, which are currently being circulated in Korea, is being established.

Main Research Activity

Beers imported from a variety of countries to be sold in South Korea were purchased (a total of 80 beer samples), and individually subjected to the analysis of carbon, oxygen and strontium isotopes and multi-elements. When the data were all combined and statistically analyzed, the result enabled the discrimination of their geographical origin by the 4 continents where they were produced (America : AM, Oceania : OC, Asia : AS, and Europe : EU).

Future Plans Research

We will develop an effective analytical methods and integrated classification system for discriminating the geographical origin of various foods.



Discriminant scatter plot was shown relatively good discrimination of geographical origin of beers by their producing continents.

Analytical Technology in Disaster Science

Environmental Monitoring and Research Team

Introduction

Scientific analysis techniques are studied to predict, prevent, and solve the national disaster and accidents that can occasionally occur.

Main Research Activity

Environmental radioactivity in groundwater was studied to evaluate the prolonged exposure to naturally occurring radioactive materials and risk.

Future Plans Research

Radius of effects on the natural occurring radionuclides will be developed to manage the groundwater quality and decrease the human risk.

Bio-imaging Technology for Early Disease Diagnosis

Bioimaging Research Team

Introduction

Myocardial infarction (MI) is the major cause of death in most industrialized society. Imaging of early disease progression and investigation of relationship between myocardial necrosis and successive inflammatory response are needed for optimal treatment of MI.

Main Research Activity

We conducted cardiac MR imaging of disease progression in acute MI using Gd-(LGE), Mn-(MEMRI), and iron oxide nanoparticles-(MNP-MRI) based contrast agents for estimation of infarcted and inflammatory regions. Extent of myocardial necrosis by LGE and MEMRI was compared to the extent of inflammation by MNP-MRI.

Future Plans Research

Further studies are necessary in order to better understand the underlying mechanism of the disease progression in the acute MI. Therefore, it is important to understand infiltration dynamics of immune cells by the cellular and molecular imaging techniques in order to examine the myocardial necrosis and the inflammatory response.



Environmental distribution of uranium in the Korean groundwater with predominant uranium species



Environmental distribution of alpha-emitting particles in the Korean groundwater



MRI images of MI mouse model, (left column) LGE, MEMRI, and MNP-MRI images from upper row, (middle column) ROI from Otsu's thresholding, (right column) Otsu's threshold values (dotted line) and sizes of necrotic and inflammatory regions



MRI and corresponding histological images (a) necrotic area (red) in LGE image, (b) immunohistochemistry image of myoglobin, (c) inflammatory region in MNP-MRI (red), (d) image of fluorescent microscopy (green : macrophage, red : iron oxide nanoparticle)

Culture Property Preservation and Analysis Technology

Geochronology Research Team

Introduction

In archaeology field, Sr isotope composition of human tooth enamel provide the scientific information about origin, mobility and culture exchange of the archeoanthropine.

Main Research Activity

This study presents strontium isotopic compositions of human tooth enamel excavated from medieval tombs in Jeoniu, southwestern Korea, aiming at deciphering the mobility of the buried population.

Future Plans Research

To able to study the different lifestyles of the archeoanthropine, we should develop a method of Sr analysis with in-site for tooth and bone of human.



The workflow chart for human saliva identification by mass spectrometry analysis



Qualitative and quantitative glycan analysis of human body fluids



To meet the demands of cutting-edge research, analysis equipment (complete product or key parts) and ambient system are remodeled and developed through core technology development of analytical equipment.

Low End Tabletop Transmission Electron Microscope

Nano-Bio EM Research Team

Introduction

This project is to develop a tabletop transmission electron microscope (TEM), which is able to analyze the characteristics of functional nanomaterial properties and the structure of bio-specimen without staining process for the first time in Korea.

Main Research Activity

In the first year (2015) of the project, the electrical and mechanical diagram of the key components of the tabletop TEM, which consist of an electron gun system, an electron optical system, a sample stage system, and an imaging system, were designed, respectively. Furthermore, the first testbed was implemented to verify and evaluate the performance of the developed components.

Future Plans Research

The prototype of the tabletop TEM will be developed within 3 years, and is planned to be commercialized through the collaboration with medium and small-sized enterprises soon for the first time in Korea. At the same time, the tabletop TEM is also planned to be utilized in bionanotechnology (BNT) field by developing technology such as an assessment technology of equipment, design of calibration sample and optimization skill.

Cryogen-Free NMR System Using High-Temperature Superconducting Magnet

Spin Engineering Physics Research Team

Introduction

A high-resolution nuclear magnetic resonance (NMR) spectrometer enabling to elucidate the structure and motion of molecules is under development. NMR has applications in various fields of industry and basic science such as development of new drugs, synthesis of materials, elemental analysis of crude oil, and study of material property.

Main Research Activity

In collaboration with SuNAM Co., LTD., the National High Magnetic Field Laboratory of USA, SciMedix Inc., the Korea Institute of Machinery & Materials were developed a 3 T conduction-cooled magnet with 2nd-generation high-temperature superconducting tapes wound, a 2-channel NMR probe, and an operating software controlling a 200 MHz digital transmitter/receiver.

Future Plans Research

A goal is to develop a prototype of the whole system of 400 MHz high-resolution solidstate NMR spectrometer including a magnet having high-homogeneity and stability magnetic field of 9.4 T, a 2-channel sample-spinning NMR probe, a 400 MHz digital transmitter/receiver, and an NMR operating software.



Biological Disaster Research Team

Introduction

Scene-applicable analytical techniques using biochemical forensic biomarkers are developing for fast, accurate and portable crime scene investigation.

Main Research Activity

A novel method for the human saliva identification was developed by saliva glycomic analysis.

Future Plans Research

A microfluidic/electrochemical-based biosensor kit will be developed to identify human saliva using human saliva glycan-specific aptamer probe.



111

Overview of Sr isotopic signatures for the

1.1

Pictures of cross section for human tooth

ename

enamel samples

2015



1st testbed for development of key element tal technologies & devices of tabletop TEM



Testbed's operation platform & electron beam image acquired by optical CCD



400 MHz NMR Magnet with 2nd-Generation Superconducting Tapes Wound and NMR Probe



External (left) and internal (right) views of 2-Channel NMR Probe

Conduction-Cooled Cryogenic Probestation

Spin Engineering Physics Research Team

Introduction

The cryogenic probe station, operating without liquid helium, is developed to measure the electric and thermal characteristic of specimen under various temperatures and magnetic fields.

Main Research Activity

The design of the conduction-cooled cryogenic probe station is performed to cool the sample stage as well as the superconducting magnet using a cryocooler. The prototype cryogenic probe station is fabricated and the performance test is carried out.

Future Plans Research

The development of vibration-control technology will be performed to attenuate the transmission of a vibration from the cryocooler's displacer to the sample stage in the cryogenic probe station.



Ion beam SIMS System

Mass Spectrometry & Advanced Instrumentation Teammentation Team

Introduction

Gas cluster ion beam and liquid metal ion beam have been developed to construct a time-of-flight secondary ion mass spectrometer, which can make an analysis of bio samples and surface of materials.

Main Research Activity

Liquid metal ion source (Ga+), Ar gas cluster generation source and their ion optics have been designed and manufactured to use as an ionization beam of TOF-SIMS. As a control unit, stabilized high voltage power supply and main control programs are fabricating. And the devices for the depth profile and imaging function modules are also developing to construct and integrate as a TOF-SIMS system.

Future Plans Research

Cluster ion beam, liquid metal ion beam and time of flight mass spectrometer will be developed and integrated as a bio TOF-SIMS to realize 3-D layer bio chemical analysis and imaging as well as semiconductor analysis.



Gas Cluster Ion Beam



Liquid Metal Ion Source

Portable Mass Spectrometer

Mass Spectrometry & Advanced Instrumentation Team

Introduction

For real time onsite detection and identification of trace chemicals, a Pocket Portable Mass Spectrometer (PPMS) is under development. The PPMS can be applied to monitor environmental pollutions and to inspect the restricted materials such as drugs, explosives chemical warfare agents and under nuclear materials onsite.

Main Research Activity

The main components were verified through compact modularity and performance testing. The intregrated system can increase the accuracy of the actual hazardous materials analysis with system optimization and database.

Future Plans Research

Through the collaboration with Korea Research Institute of Standards and Science (KRISS) and Bioneer Corporation, a prototype of the world's smallest PPMS will be fabricated soon and its performance to detect gas samples will be test in the field.

Thermal Imaging Inspection Equipment for Stacked Semiconductor Chip

Optical Instrumentation Development Team

Introduction

We are developing a thermal imaging microscope system for isolating and characterizing the defects in the three-dimensional semiconductor. Rapid development of the system is important according to 3D integration techniques are emerging.

Main Research Activity

Infrared optics objective lens, a highly sensitive thermal imaging microscope systems and associated signal processing algorithms are being developed as well as fieldtesting of the system with some stacked semiconductor memory chips in a semiconductor company.

Future Plans Research

It is planning to expand into the next-generation semiconductor test equipment market through the technology transfer and the joint testing of prototypes with a semiconductor company.



Compact Ion Chamber



Portable Mass Spectrometer System



Thermal Imaging Microscope System



On-site equipment under tests

Description of photograph | 2015 KBSI Science Image Contest Bronze Prize Winners's Works <Midnight Forest with Alive In Everything>, Ah-ra Ryou (Chungnam National University Hospital) CLSM image of a rat cochlea (X 400)

ADVANCE IN ANALYSIS SUPPORT & VALUE CREATION FOR SMEs

KSBI contributes to the realization of creative economy by upgrading analysis support services, which is the key mission of the institute, and by the providing technical support to small and medium businesses using knowledge and know-hows accumulated from the operation of high-tech research facilities and equipment. KOREA BASIC SCIENCE INSTITUTE

ANNUAL REPORT 2015

- Acquisition of ISO 9001 Certification
- Strengthening SMEs support and cooperation Industry-research institutions
- Program for Regional Basic Research and Technology Development
- Technology transfer

Acquisition of ISO 9001 Certification

Introduction

KBSI obtained the international standard for gualification management system on the overall process of 'bio, environment, and nano material analysis support service and research development of basic scientific equipment', which are the main responsibilities of KBSI, in order to improve the efficiency and effectiveness of internal work process as well as the reliability for external customers.

Achievements

KBSI established manuals for guality measure and guality control management, and confirmed 23 quality process protocols in 5 categories including system operation, research support management, product attainment, measurement / analysis / improvement. In addition, KBSI produced analytical operation manuals and standard protocols for 167 research instruments.

Future Plans

KBSI focuses on the implementation of regular internal inspections for the establishment of quality management system and increase of reliability through continuous maintenance control; system improvement and immediate response to internal/external conditions of KBSI for satisfaction of ISO requirements; and renewal of approval for the follorwing year and the enhancement of understanding on ISO through TF organization and education.



Partner Companies

Strengthening SMEs Support and **Cooperation Industry-research Institutions**

Introduction

KBSI contributes to realization of the creative economy through government's support on SMEs by focusing on concentrated support for the SMEs that need assistance for research and development using the advantages of KBSI.

Achievements

Based on the open-type collaborative ecosystem plan funded by the Ministry of Science, ICT and Future Planning, KBSI established and is managing the demand-oriented support system for selected 30 partner companies. The SME were selected among the companies that have experience with KBSI equipment utilization, cooperative R&D, technology transfer, technology consultation and advice, based on their potential to develop through collaboration with KBSI. KBSI also contributed to the enhancement of research ability of government funded family companies by participating in 'support project for professional technical training of government funded research institutes' and providing professional technical training through outstanding experts and equipment owned by government funded research institutes.

Future Plans

KBSI will play the core role in SMEs technology innovation system in order to allow SMEs to be the leaders of the creative economy through invigoration of SMEs support system and establishment of close cooperation with SMEs.

Certificate KOREA BASIC SCIENCE INSTITUTE 분석작업표준지침서 15/3 8001-3998 Optical Spectrometer (05154) stany fer ICR -00



Guideline o	on work standar	d (example)





2015 KBSI meeting and on-site visit with partner companies



Providing properties analysis for Aprogen Inc. with regard to the clinical test of antibody medicines in overseas countries



Professional technology training for governmentfunded family companies

Support of the Joint Utilization of Research **Equipment for SMEs**

Strengthening SMEs Support and Cooperation Industry-research Institutions

Introduction

KBSI is contributing to solving difficult technical problems of SMEs and improving the technology competitiveness of SMEs through revitalization of joint utilization of research equipment for SMEs.

Achievements

KBSI opens its research equipment to SMEs that experience difficulties with technology development due to lack of research equipment. KBSI headquarters (Daedeok, Ochang) and 10 regional centers with specialized research fields are connected to regional strategic industries to support utilization of research equipment that facilitates test, analysis, measurement, and evaluation for development of new technologies and products and improvement of manufacturing processes of SMEs.

Future Plans

KBSI will take advantage of its unique and advanced research and development infrastructure in order to strengthen industry-institution cooperation and also contribute to the increased utilization of national research equipment.



Support of remodeling and development of equipment performance for SMEs



KBSI technology consulting center for SMEs

3

Program of Regional Basic Research and Technology Development

Introduction

KBSI supports basic research by utilizing the know-hows about operating equipment and analytic technology and promotes the product development and commercialization of SMEs through establishing demand-responding analysis environment.

Achievements

KBSI is securing the sustainable SMEs growth system through provision of field analysis infrastructure for SMEs and promotion of technology commercialization and development; developing programs for joint research on basic research of SMEs and improvement of analytical equipment utilization; and developing commercialization technologies of market creation for improvement of profit structures of SMEs.

Future Plans



With securement of basic research infrastructures for SMEs, KBSI will contribute to the efficient utilization and development of national research equipment through support of sustainable growth and maintenance of equipment, and the growth of SMEs through development of analytical equipment and breakthrough commercialization technologies.

Development of Chamber-Type Probe Station

Technology Transfer

Introduction

KBSI's Technology Licensing Office (TLO) provides programs such as technology assessment, discovery of outstanding technology, technology marketing and technology transfer contract, for efficient commercialization of valuable research outcomes.

Achievements

KBSI actively performed technology transfer with Technology Licensing Organization (TLO) and established the first enterprise institute (Hyper Nine Ltd.) for direct commercialization of KBSI-owned technologies. KBSI became the first in Korea to build the mass production system for rare metals with high-purity (99.9999%) such as indium (In), gallium (Ga), and *etc.*

Future Plans

KBSI will expand the technology transfer of research and development into private enterprise, fortify the support for utilizing the transferred technology in industry, and reinforce the supporting basis for the business foundation by the researcher who participated in the technology development.



Agreement Ceremony (HANMAC)



Agreement Ceremony for Establishment of Enterprise Institute (KNM)







Description of photograph | 2015 KBSI Science Image Contest Winners' Works <The Moment of Birth>, Oh-sung Kwon (Korea Institute of Science and Technology) CLSM Image of a rat subthalamic nucleus (X 20)

REINFORCEMENT & PROMOTION OF NATIONAL BASIC SCIENCE SUPPORT SYSTEMS

KBSI manages and supervises national research facilities and equipment for the advancement of research facilities and equipment, which becomes the foundation for national development of science and technology. We are contributing to the expansion of science culture by training specialists of analytical science and equipment, and providing various opportunities for youths to experience science. KOREA BASIC SCIENCE INSTITUTE

ANNUAL REPORT 2015

- Operation of National Research Facilities & Equipment Center
- KBSI's Outreach Program
- Operating Graduate School of Analytical Science and Technology
- Journal of Analytical Science and Technology
- Analytical Science Conference
- Online Research Service System
- National & international networks

Operation of National

Research Facilities &

Equipment Center

NFEC is established by the Framework Act on Science and Technology to provide a systematic support for scientific development in research facilities and equipment. NFEC, as an exclusively responsible Korean organization, will endeavor to maximize R&D productivity by providing an overall management and a systematic support for the development of research facilities and equipment for strategic investment, promotion of joint-utilization of research facilities, and the development of high-skilled manpower.



Introduction

Supports Policymaking and Improves the System of **National Research Facilities** & Equipment

We act as a national think-tank by supporting an effective operation and management for boosting the efficiency of investment of national research facilities & equipment, such as systematic-strategic construction, promotion of co-utilization and recycling idling and less used equipment.

Achievements

In 2015, support was carried out for 35 policy-makings of research facilities and equipment, including the National Science and Technology Council agenda. Also, we amended "Framework Act on Science and Technology and its Enforcement Decree" and "National Research Facilities and Equipment Management Standards" to spread the implementation of government policies and institutions.

Future Plans

Our plan is to maximize investment efficiency and utilization of national research facilities and equipment, establish a detailed plan for execution of Government R&D Innovation Plan, and pursue such a legal basis established by the legislation.







Policy agenda

Researcher consultation meetings

Presentation and discussion on standard manual revision

2015

Organization and Management of the "Deliberative Council on Research Facilities and Equipment Budget"

Organize and Operate

Technology Information

National Science &

Service

ANNUAL REPORT

Introduction

We improve the efficiency of national R&D investment by operating the "Deliberative Council on Research Facilities and Equipment Budget" for feasibility examinations when the strategy and finance allocates the national R&D budget.

Achievements

We reduced budget of 46.4 billion KRW through holding deliberative council on the research facilities & equipment budget twice and enhanced effective execution of R&D budget by forming the council for amendment regularly (5 times) according to the changes of research environment.

Future Plans

Through the advanced propulsion of Research Equipment Deliberations Service (RED, http://red.zeus.go.kr), online deliberation, as well as implementation status check is going to be built entire equipment lifecycle management system of deliberation.



Council on the research facilities & equipment budget

Introduction

We provide major information and national statistical indicators needed in order to establish effective infrastructure policy and invest strategically by upgrading collection, management, and distribution system of research facilities and equipment built through government R&D budget.

Achievements

We promoted the advancement of system to examine the similarity of the instruments, and built a system calculating the lowest price, highest price and the reference price for the same model. In addition, we developed deployment-plan specific function based on the collection of facility/equipment approval numbers and any user changes about key items has prevented by introducing the approval process.

Future Plans

We plan to upgrade National Science & Technology Information Service (NTIS) through and expansion of model library, development of information recommendation function, advancement of management functions, and link between NTIS and equipment management systems of research institutes.



National Science & Technology Information Service (NTIS)



Commissions and committees awarding deliberations held

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The major screens from NTIS

R&D Equipment Engineer Education Program

Expensive Equipment

Operating Personnel

Support Programs

Introduction

We improve the efficiency of national R&D investment by systematically training equipment engineers who are exclusively in charge of operation and management of research instruments.

Achievements

We designated 11 institutions of professional education, selected 130 students as the 4th trainees and developed 33 textbooks in order to cultivate equipment engineers who are exclusively in charge of operation and management of research facilities and equipment. Also, we have prepared training videos about 20 sets of key equipment.

Future Plans

Through the activation of professional qualification scheme to promote employment and professional career as an early settlement, and by linking research equipment engineer specialized training courses on a regular degree program, the scheme plans to realize the talent in practice.



R&D Equipment Engineer Education program

Textbooks for the programs

Introduction

We support operation costs of employment to universities and research institutes that own research equipment with values of 100 million won more for promoting shareduse of the equipment and equipment operating personnel's employment stabilization.

Achievements

In 2015, a total of 562 million won was spent to select and support 27 sets of equipment, and through the openness of the equipment, more than 41,205 samples were analyzed. In addition, we carried out 65 training programs and consulted in 94 cases, which contributed to the excellent results of research derived.

Future Plans

Through improving the effectiveness and satisfaction of personnel support we plan to facilitate the joint use of expensive national research equipment.



Selection and evaluation meeting for entrusted projects of the expensive research equipment operation specialist supporting project



Business fair and promotion of the expensive research equipment operation specialist supporting project



2015





Official documents and reports of survey on national research facilities and equipment



National research facilities & equipment trends 2014

ZEUS Research Facilities and Equipment Portal

ZEUS

Main page of the ZEUS equipment utilization portal



FE area for selecting and providing a variety of information

ANNUAL REPORT

Introduction

Implementation of the research field "National Research Facilities & Equipment Management Manual" status, difficulties over the status check of the operating personnel, including employment and treatment are provided to identify difficulties and make improvements. In addition, we provide overall research and analysis about investment and utilization status of national research facilities and equipment.

Achievements

In 2015, we promoted a national research facility management survey for research facilities and equipment management system status and identify improvement targets sought a total of 418 institutions. In addition, we published 2014 National Research Facilities & Equipment Trends.

Future Plans

We plan to conduct research topics for future surveys, reflecting the revised "National Research Facilities & Equipment Management Manual", and upgrade online survey system for the year 2016. Furthermore, we plan to improve the research and analysis report through the analysis item based on the diversification of analysis items.

Introduction

ZEUS, a portal service related to research facilities and equipment for overall departments, offers information and services such as reservation of co-utilization facilities, consultation with specialists, relocation of non-operating and less utilized equipment, sharing knowledge, and equipment operation in order to maximize utilization of national research facilities and equipment.

Achievements

KBSI was able to reinforce the information collecting system of the co-utilizable facilities and equipment through information linking with research institutes that have their own reservation system for research equipment. We maximized the recycling function of facilities through sharing and expansion of non-operating and less utilized equipment from national and private research institutes, and we also contributed to increasing investment efficiency of research equipment by building integrated management system of information on co-utilizable equipment of different departments and institutes.

Future Plans

We will promote system upgrade for promoting co-utilization of research facilities and equipment, and expand collaboration with expert institutes from different departments as well as private research institutes.

KBSI's Outreach Program

Introduction

KBSI's education and outreach programs, "X-Science" and "Junior Doctor" strive to "inspire and motivate students to pursue careers in science and technology" and to "engage the public in sharing the experience of exploration and experiment" by utilizing R&D resources.

Achievements

Lab Tour

School Visit Program

Inviting Students to Lab

Research & Education

Meet The Scientist

Teacher Training

Career Guidance Program

In 2015, KBSI provided students and the public with "X-Science", "Junior Doctor", and "Yuseong-gu Science Mentor" programs, and a total 11,831 youths and the public participated in those programs.



2015 Junior Doctor open ceremor







Inviting students who live in the suburb of Daeieon to KBS



2015 Junior Doctor Essay Contest award



Yuseong-gu Science Mentor

X-Science



2 185 4441 41 45 5455 44 14.288 4842 8 2447 8584 24 145 84 1584 44 (284748) 8

Received Grand Prize for Education Donation Award

Operating Graduate School of Analytical Science and Technology

2015



Research equipment specialized education support project presentation



Strengthening of ability program



The analysis equipment professionals in the license ceremony

Journal of Analytical Science and **Technology**



Homepage of JAST website



JAST (volume 6, number 1)

Introduction

Graduate School of Analytical Science and Technology (GRAST) was jointly established with Chungnam National University (CNU) as a new university-institute cooperation model to combine education and S&T research. Contributing to national S&T development and securing global research competitiveness, it aims to become the world's leading graduate school in the field of analytical S&T.

Achievements

In 2015, there were 22 faculties in GRAST, 11 researchers belonging to KBSI and 11 professors belonging to CNU. In the same year, 26 master course and PhD course students entered GRAST and 20 students graduated. In order to cultivate students of executive ability in the field of analytical equipment, GRAST operates expert certification programs. As a result 15 students got a license in the field of electron microscope, mass spectrometry, NMR, etc.

Future Plans

GRAST will foster specialists required in the field of research and industry through various programs, including industrial visits, training, commissioned education.



MOU between GRAST NRICH and KRSI

Introduction

The Journal of Analytical Science and Technology (JAST) is a fully open access peerreviewed scientific journal launched by KBSI in 2010. JAST publishes original research and review articles on analytical principles, techniques, methods, procedures, and equipment in the fields of physics, material science, earth & environmental science, chemistry, biomedical science, etc. From 2013, JAST is publishing articles through Springer to improve the journal quality.

Publication Status

JAST publishes peer-reviewed articles in English. The electronic version (e-ISSN: 2093-3371) is available at the Springer's journal homepage, www.jast-journal.com, immediately upon publication, and the printed edition (p-ISSN: 2093-3134) is issued biannually in June and December. All articles published in JAST are open and free-accessible. In 2015, 38 original research and review papers were published on-line out of 151 manuscripts submitted to JAST from 28 countries all over the world and the total number of downloaded articles is 8.842.

Future Plans

The purpose of JAST is to inform the researchers in the world of the significant professional achievements in science by providing unlimited access to the latest advances of the analytical science. The goal of JAST is to be an internationally influential and widely-read analytical science journal. To improve the quality of the articles, JAST has worked with Springer since 2013. JAST is indexed in CrossRef, Google Scholar, OCLC and Summon by Serial Solutions and aims within a few years to be indexed in major international databases, such as SCI, SCOPUS, and Medline/PubMed.



9178 586 11,831

429

73

48

39

310

1138

30

Number of programs Number of participants

19

2

1

15

16

10

1

399

16

472

Future Plans

Junior Doctor

Total

Yuseong-gu Science Mentor

X-Science

KBSI has provided various outreach programs since 2004. X-Science and Junior Doctor programs are now acknowledged for outstanding creative experience activities for youth and the public. By improving the programs, KBSI will continue to make effort for X-Science and Junior Doctor to be representative scientific outreach programs in Korea.







1st Creative idea in analytical science 5th GRAST International workshop Awards

Analytical Science Conference

Introduction

ICAST, a sole conference dedicated to analytical science & technology in the world, is providing new milestones for scientists to share their ideas on advancement of analytical science & technology.

Achievements

For this year, the conference focused on the research fields such as Brain Science, Natural Disaster Microbiology, Protein Function, Bio Imaging and Cell Biology in order to face recent development and future perspective of analytical science related to the field of life science.

Future Plans

ICAST is expected to become a symbolic meeting to foster R&D cooperation in various fields of analytical science & technology, such as Life Science, Materials, Environmental Science and Instrumentations.

NATIONAL CONFERENC

ICAST 2015 attendees



ICAST 2015 Nobel Lecture

ANNUAL REPORT

Introduction

Online research service system (OCS) utilizes the most advanced cutting-edge IT technologies for increasing the research support easiness/ease. Users can join simultaneously the analysis process through OCS's technologies in the headquarters and local center. On OCS's web service, to share their opinion for sample analysis, users can communicate with KBSI's operators with video conference system. OCS's web service provide various fields of research support (data analysis (S/W), Q&A etc.).

Achievements

tions.

Future Plans

Improving the intelligent OCS for promotion of share-use of research facilities. Upgrading OCS's performance for R&D utilization improvement. Contributing public understanding of science & technology.





Popularization of science with online research supporting system

2015

Online Research

Service System

About 53 different types of research equipment have been utilized in various research areas with application of online research service system, and the high-resolution analytical image transfer technology based on media server has been expanded for easy connection from PC and mobile devices. Also KBSI has put its effort for best online research service through continuous improvement on equipment and operation condi-

National & International networks

National networks

Seoul

 Sungkyunkwan University Korea University Honaik University Seoul National University Sejong University · LG Sangnam Library Kwangwoon University • Mine reclamation Corp. (MIRECO) Korea Foundation for the Advancement of Science & Creativity National Institute of Scientific Investigation SEM Technology Co.,Ltd Poongsan Corp. · Ewha Womens University Korea Conformity Laboratories Ahnse Law Offices Gwacheon National Science Museum Center for Women in Science. Engineering and Technology Korea Foundation for the Advancement of Science and Creativity (KOFAC) Hanyang University Industry Academic Cooperation Foundation Kyunghee University Medical · Bio-New Materials Convergence Research Corporation Nuclear Safety Evaluation Samsung Hospital Transparency International Korea Seoul Seodaemun-gu office Wips Korea University Medical Center (KUMC) Yonsei University Health System (YUHS)

Seiona

 National Research Council of Science & Technology

3

Incheon Korea Polar Research Institute (KOPRI) National Institute of Environmental Research (NIER)

Л Gyeonggi-do

Goyang Korea Institute of Construction Technology Seongnam · D.A.K Korea Korea Electronics Technology Institute Suwon Chemical & Biological Detection-Research Center Asta Inc.

Daeieon

(UST)

Daejeon Technopark

Hannam University

Mineral Resources

National Plastic Co., Ltd.

Mediscov Inc.

Bioneer Corp.

DaedeokNet

Solgent Inc.

Medicine

Research

Institute

Materials

Institute

Jeollabuk-do

Jeonju

Suncheon

• MS corp.

Science Institute

Research Institute

Cultural Heritage

Graduate School of Analytical

Korea Institute of Oriental

Korea Research Institute of

Standards and Science

Korea Institute of Energy

Korea Research Institute of

Korea Atomic Energy Research

Korea Astronomy and Space

Korea Institute of Machinery &

Korea Aerospace Research

Chonbuk National University

Korea Institute of Carbon

Convergence Technology

Sunchon National University

Yulim Industrial Co., Ltd.

Chemical Technology

Gangwon-do Gangneung Gangneung-Wonju National University Marine Bio Advanced Material Cluster Center Chuncheon Kangwon National University Kangwon National University Hospital Scripps Korea Antibody Institute

Chunacheonabuk-do

Chungbuk Osong Medical Innovation Foundation • WISE Regional Agency of Chungbuk Chung-buk superior small&medium business association Cheonaiu · Chunacheonabuk-do Chungbuk National University Small and Medium Business Administration Chungbuk Creative Economy Innovation Center Small and Medium Business Technology Innovation Council Chungbuk Branch Small and Medium Cooperation Chungbuk Council Chunabuk Business Agency Korea Institute of Human Resources Development in Science & Technology Cheongwon Chungbuk Techno park Bibong Elementary School

Chungcheongnam-do

Cheonan

& Education

Technology

Institute

Hoseo University

Korea Institute of Industrial

Geumsan International Ginseng and Herb Research Institute Asan Soonchunhyang University Jochiwon Sejong City Office of Education Gongju Kongju National University Gyerongsan Natural History Museum Buveo Buyeo National Museum

10

 Korea University of Technology Gwangiu Chosun University Honam University Chonnam National University Gwangju Metropolitan City Gwangju Technopark Korea Automotive Technology World Institute of Kimchi Korea Photonics Technology Institute

1 3 Korea Advanced Institute of Science&Technology (KAIST) Chungnam National University 6 2 0 University of Science&Technology 8 · Korea Research Institute of Bioscience and Biotechnology National Science Museum Korea Institute of Geoscience and 9 Daeieon Metropolitan City Hanbat National University 10 1 Institute for Basic Science OVIUSHealth & Environment Daeieon Bukbu Fire station 17 National Research Institute of

Science and Technology (GRAST)

Jeollanam-do Jeonnam Bioindustry Foundation (JBF) Jeollanam-do

12 Gyeongsangbuk-do

Pohang Pohang Accelerator Laboratory Gyeongsangbukdo Institute of Science Education National Institute for Nanomaterials Technology Biology Research Information Center

 Research Institute of Industrial science & Technoloav

13

Gveongsangnam-do Jiniu · Korea Institute of Ceramic

Engineering And Technology Changwon Korea Electrotechnology Research Institute Korea Institute of Materials Science

14 Daegu

 Kyungpook National University Daegu Metropolitan City Daegu Gyeongbuk Medical Innovation Foundation Daegu National Science Museum (DNSM)



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16 Busan

 Dong-Eui University Pusan National University Federation of Busan Science and Technology Dowtechwin Corp. · Macrochemtech Corp. Busan Metropolitan City Dongnae Office of Education Taesungpolitech Corp. Silla University Korea Industrial Complex Corp in Dongnam area Busan Metropolitan City Bukbu Office of Education

17 Jeju

 Jeju National University Jeju Free International City Lava Ocean Water Industrialization Supporting Center at Jeiu Technopark











Vietnam

China (IHIP PKU)

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Kyoto University New Energy Research Institute

 National Institute for Basic Biol-ogy (NIBB) National Institute for Physiological Sciences

 National Institute for Material Sciences (NIMS) BIKEN Yokohama Institute Nagova University Bioscience and Biotechnology Center High Energy Accelerator Research Organization (KEK)

Bioprocessing Technology Institute (BTI)

 Institute of Marine Biochemistry (IMBC) Institute of Materials Science (IMS)

10 USA

- Lawrence Livermore National Laboratory (LLNL)
- · University of California, San Diego (UCSD)
- Salk Institute for Biological Studies (SI)
- National High Magnetic Field Laboratory (NHMFL), University of Florida
- University of Massachusetts Medical School (UMMS)
- Havard Medical School / Messachusetts General Hospital Martino Center
- University of Texas University of Texas Health Science Center at Tyler
- University of Arizona (UOA)



11 **Δ**ustralia

University of Wollongong (UOW)



12 Czech Republic

Institute of Scientific Instruments (ISI)

· Pecking University Institute of Heavy Ion Physics

 MMC at Shanghai Jiao Tong University State Key Lab of Metal Matrix Composites

Description of photograph | 2015 KBSI Science Image Contest Silver Prize Winners' Works <Kakariki parrot>, Seo-hee Choi (Pusan National University School of Medicine) FE-SEM image of wings of cabbage butterfly (X 130)

KOREA INSTITUTE

ANNUAL



BASIC SCIENCE

REPORT 2015

Development of Phototherapeutic Agent of Alzheimer's Disease Using Photosensitizers

Seongsoo Lee (Gwangju Center), Co-1st Author

Representative Research Publications in Year 2015

Photoexcited porphyrins as a strong suppressor of β-amyloid aggregation and synaptic toxicity (Sep. 21, 2015)

Journal

Title

ANGEWANDTE CHEMIE-INTERNATIONAL EDITION (IF:11.261)

Authors

Byung II Lee (KAIST), Yoon Seok Suh (KRIBB), Joon Seok Lee (KAIST), Ae yeong Kim (KRIBB), O-Yu Kwon (Chungnam National Univ.), Kweon Yu (KRIBB), & Chan Beum Park (KAIST)

Abstract

The abnormal assembly of β-amyloid (Aβ) peptides into neurotoxic, β-sheet-rich amyloid agg-regates is a major pathological hallmark of Alzheimer's disease (AD). Light-induced photosensitizing molecules can regulate Aß amyloidogenesis. Multiple photochemical analyses verified that photoactivated meso-tetra (4-sulfonatophenyl) porphyrin successfully inhibits Aß aggregation in vitro. Furthermore, A β toxicity was relieved in the photoexcited-TPPS treated Drosophila AD model. TPPS suppresses neural cell death, synaptic toxicity, and behavioral defects in the Drosophila AD model under blue light illumination. Behavioral phenotypes, including larval locomotion defect and short lifespan caused by AB overexpression, were also rescued by blue light-excited TPPS. Here, we explored a photoinduced suppression of Aβ neurotoxicity in vivo for the first time as well as Aβ aggregation in vitro by porphyrin molecules.

Expected Contribution to Science & Technology

Our results will provide new insights into photodynamic therapy of AD by showing that photoexcited porphyrin is an effective inhibitor against AB toxicity.



Diagram for inhibition of Aß self-assembly into fibril ex vivo and Aß synaptic toxicity by blue LED light-sensitized TPPS using Alzheimer's disease mode animal



Cover picture of Angewandte Chemie (2015)

2

Tissue-Based Feeding Method for Metabolically Labeling the Cell-Surface Glycans

Kyung-Bok Lee (Division of Convergence Biotechnology), **Co-corresponding Author**

Representative Research Publications in Year 2015

Title Neurons (Jan. 20, 2015)

Journal PNAS U.S.A (IF:9.647)

Authors

Kyungtae Kang (KAIST), Yoonkey Nam (KAIST), Hee-Yoon Lee (KAIST) & Insung S. Choi (KAIST)

Abstract

Expected Contribution to Science & Technology

This method can be used as a versatile tool for investigating the PSA-mediated dynamic regulation of neurite and synaptic developments.





Tissue-Based Metabolic Labeling of Polysialic Acids in Living Primary Hippocampal

The post-translational modification of neural cell-adhesion molecule (NCAM) with polysialic acid (PSA) and the spatiotemporal distribution of PSA-NCAM play an important role in the neuronal development. We understand this phenomenon, we developed a tissue-based strategy for metabolically incorporating an unnatural monosaccharide, peracetylated N-azidoacetyl-D-mannosamine, in the sialic acid biochemical pathway to present N-azidoacetyl sialic acid to PSA-NCAM. The imaging of PSA-NCAMs at 12 DIV indicated that sialic acid kept synthesizing in neurons (and astrocytes) in the matured neuronal network.

Schematic illustration of the metabolic labeling of PSA-NCAMs in living primary hippocampal neurons



Fluorescence micrographs of the PSA-NCAMs in living neuron cells

A 3D Human Neural Cell Culture System for Modeling Alzheimer's Disease

Young Hye Kim (Division of Convergence Biotechnology), Co-1st Author

Representative Research Publications in Year 2015

A 3D Human Neural Cell Culture System for Modeling Alzheimer's Disease (Jun. 11, 2015)

Journal Nature Protocols (IF: 9.673)

Authors

Title

Se Hoon Choi (Harvard Medical School-MGH), D'Avanzo Carla (Harvard Medical School-MGH), Rudolph E. Tanzi (Harvard Medical School-MGH) & Doo Yeon Kim (Harvard Medical School-MGH)

Abstract

Stem cell technologies have facilitated the development of human cellular disease models that can be used to study pathogenesis and test therapeutic candidates. These models hold promise for complex neurological diseases such as Alzheimer's disease (AD) because existing animal models have been unable to fully recapitulate all aspects of pathology. We recently reported the characterization of a novel three-dimensional (3D) culture system that exhibits key events in AD pathogenesis, including extracellular aggregation of β-amyloid and accumulation of hyperphosphorylated tau. Here we provide instructions for the generation and analysis of 3D human neural cell cultures, including the production of genetically modified human neural progenitor cells (hNPCs) with familial AD mutations, the differentiation of the hNPCs in a 3D matrix, and the analysis of AD pathogenesis. The 3D culture generation takes 1-2 days. The aggregation of β -amyloid is observed after 6-weeks of differentiation followed by robust tau pathology after 10-14 weeks.

Expected Contribution to Science & Technology

This protocol is useful for modeling neurodegenerative disease and studying AD pathogenic mechanisms, biomarker discovery, and drug screening.



Overview of the ReN VM cell 3D culture protocol



B-amyloid plaques of human neural cell AD mode



Development of Nano-Bioelectronic Nose That Is More Precise Than Human

Hyun Seok Song (Division of Convergence Biotechnology), Co-1st Author

Representative Research Publications in Year 2015

Title An Ultrasensitive, Selective, Multiplexed Super-Bioelectronic Nose That Mimics the Human Sense of Smell (Oct. 14, 2015)

Journal Nano Letters (IF:13.592)

Authors

Univ.)

Abstract

ponent analysis.

Expected Contribution to Science & Technology

This technology can substitute human nose and can be widely used for the detection of toxic gas, cancer biomarker that is contained in breath or urine, volatile organic compound, perfume, food, drug and biochemical weapon. This bioelectronic nose also can be applied for the development of future technology including smelling TV through the coding of human olfactory signal.



Functional anatomy of human olfactory system and components of multiplexed bioelectronic nose simulating each functional stages of human nose

Oh Seok Kwon (Korea Research Institute of Bioscience and Biotechnology), Seon Joo Park (Seoul National Univ.), Tai Hyun Park (Seoul National Univ.) & Jyongsik Jang (Seoul National

Combinational coding of human olfactory receptors (hORs) is essential for odorant discrimination in mixtures. The binding of odorants to their each specific ORs triggers olfactory signals and transferred to olfactory bulb through multiple OSNs. The forebrain recognizes smell after the combination of multidimensional signals in olfactory bulb. We reported the first demonstration of an artificial multiplexed super-bioelectronic nose (MSB-nose) that mimics the human olfactory sensory system, leading to high-performance odorant discriminatory ability in mixtures. Specifically, portable MSB-noses were constructed using highly uniform graphene micropatterns (GMs) that were conjugated with two different hORs, which were employed as transducers in a liquid-ion gated field-effect transistor (FET). Field-induced signals from the MSB-nose were monitored and provided high sensitivity and selectivity toward target odorants (minimum detectable level: 0.1 fM). More importantly, the potential of the MSB-nose as a tool to encode hOR combinations was demonstrated using principal com-



Human olfactory combinatorial code analyzed by multiplexed bioelectronic nose

Polymer Nanowires for High Performance Field Effect Transistors and Phototransistors

Hionsuck Baik (Seoul Center), Co-corresponding Author

Representative Research Publications in Year 2015

Title High Aspect Ratio Conjugated Polymer Nanowires for High Performance Field Effect Transistors and Phototransistors (May. 11, 2015)

Journal

ACS Nano (IF:12.033)

Authors

Hyun Ah Um (Korea Univ.), Dae Hee Lee (Korea Univ.), Dong Uk Heo (Korea Univ.), Da Seul Yang (Korea Univ.), Jicheol Shin (Korea Univ.), Min Ju Cho (Korea Univ.) & Dong Hoon Choi (Korea Univ.)

Abstract

We synthesized a highly crystalline DPP-based polymer, DPPBTSPE, which contained 1,2bis (5-(thiophen-2-yl) selenophen-2-yl) ethene as a planar and rigid electron donating group. High - and low- molecular weight (MW) DPPBTSPE fractions were collected by Soxhlet extraction and were employed to investigate their unique charge transport properties in macroscopic films and single crystalline polymer nanowire (SC-PNW), respectively. The low-MW polymer could provide well isolated and high aspect ratio SC-PNWs, in which the direction of π - π stacking was perpendicular to the wire growing axis. The field effect transistors made of SC-PNWs exhibited remarkably high carrier mobility of 24 cm² V¹ s⁻¹. In addition, phototransistors (PTs) made of SC-PNW showed very high performance in terms of photoresponsivity (R) and photoswitching ratio (P). The average R of the SC PNW-based PTs were in the range of 160170 A W⁻¹ and the maximum R was measured at 1920 A W⁻¹, which is almost three orders higher than that of thin film-based PT device.

Expected Contribution to Science & Technology Fabrication of polymer based photo and display device



DPPBTSPE polymer nano wire and schematic description of transistor



(a, b) TEM image of PNWs, (a) high - and (b) low- MW DPPBTSPE. (c, d) low dose TEM diffraction pattern from PNWs, (c) high - and (d) low - MW DPPBTSPE



3D Structure Determination of Onion-Like Vesicles Having the Unique Stepwise Drug-**Releasing Behavior Using Cryo-Electron** Tomography (Cryo-ET)

Sangmi Jun (Division of Convergence Biotechnology), Co-1st Author

Representative Research Publications in Year 2015

Title

Journal Advanced Functional Materials (IF:11.8)

Authors

Joo Shin (UNIST) & Eunji Lee (GRAST)

Abstract

We utilized biocompatible and degradable polymers and a new method, emulsificationinduced assembly to form onion-like vesicles having the unique stepwise drug-releasing behavior. In addition, we interpreted the 3D multi-walled structure of the vesicles using cryoelectron tomography (cryo-ET) which allows 3D visualization of the nanoparticles at molecular resolution in a hydrated condition. The vesicle has the space between the walls filled with water and the feature of the vesicle could increase a drug-loading efficiency.

Expected Contribution to Science & Technology

This paper shows the fabrication of the aqueous onion-like vesicles containing water channels between the walls using the new assembly method to form the unique and complex nanoparticles. In addition, this interprets the detailed ultrastructure of the vesicles under near-native conditions with 3D cryo-ET. The combined Bio-Nano technology is applied to investigate NBT applications such as drug delivery system using NPs.



Onion-like vesicles generated from emulsificationinduced assembly of semicrystalline polymer amphiphiles

Stepwise Drug-Release Behavior of Onion-Like Vesicles Generated from Emulsification-Induced Assembly of Semicrystalline Polymer Amphiphiles (Jun. 18, 2015)

Mi-Kyoung Park (GRAST), Inhye Kim (GRAST), Seon-Mi Jin (GRAST), Jin-Gyu Kim (KBSI), Tae



3D structural elucidation of the onion-like vesicles with water channels using cryo-electron tomography

Investigation on Behavior of Water and Pro-8 ton in Nafion Polymer Electrolyte Membrane Oc Hee Han (Western Seoul Center), Co-corresponding Author

Representative Research Publications in Year 2015

Title Nanometer-Scale Water- and Proton-Diffusion Heterogeneities Across Water Channels in Polymer Electrolyte Membranes (Mar. 16, 2015)

Journal

Angewandte Chemie International Edition (IF:11.336)

Authors

Jinsuk Song (University of California at Santa Barbara, USA) & Songi Han (University of California at Santa Barbara, USA)

Abstract

Overhauser dynamic nuclear polarization relaxometry detected that dynamics of water and proton were much faster near the inner wall than in the middle of hydrophilic channels in Nafion polymer electrolyte membrane. This was explained by the hydrophobicity of the inner surface of the channels.

Expected Contribution to Science & Technology

- Development of polymer electrolytes with improved ionic conductivity
- · Surface modification for improved ionic/molecular dynamics properties

Schematic of hydrophilic channels in Nafion polymer electrolyte membrane and water and proton ionic diffusion rates



A photo of Overhauser Dynamic Nuclear Polarization Nuclear Magnetic Resonance Spectrometer



Quantum Property Imaging for Enhancing **Optoelectronic Nanodevice Performance**

Weon-Sik Chae (Daegu Center), Co-corresponding Author

Representative Research Publications in Year 2015

Title Controlled Vortex Formation and Facilitated Energy Transfer within Aggregates of Colloidal CdS Nanorods (Apr. 28, 2015)

Journal Chemistry of Materials (IF:8.354)

Authors

Abstract

the NR assembly.

Nowadays, semiconductor nanoparticles are key building blocks for the applications of high-brightness display and solar cell industries. This finding enables a base-stone for greatly enhancing nanodevice performance based on the observed direct quantum characteristics imaging technique between nanosystems.



TEM images of CdS nanorod assembly

Whi Dong Kim (KAIST), Wan Ki Bae (KIST) & Doh C. Lee (KAIST)

Vortex formation is observed in the colloidal CdS nanorod (NR) aggregates. When NR clusters are deposited on a substrate, the tips of the NRs are immobilized on the substrate, and capillary forces give rise to a net inward tilting as the solvent evaporates, eventually leading to the formation of vortices. Solvent polarity turns out to play a critical role in controlling the structure of vortices. Fluorescence lifetime imaging microscopy (FLIM) of the ensembles reveals that the vortex structures have profound influence on the energy transfer rate within

Expected Contribution to Science & Technology

Time-resolved fluorescence image of CdS nanorod assembly

The Research of 2D Black Phosphorus (BP) Silica Nanocapsules for Co-Treatment of Oil / 10 9 Water Separation and Water Purification Nanomaterials for Biomedical Applications Hyun Uk Lee (Division of Environmental & Material Sciences), Ha Jin Lee (Western Seoul Center), Corresponding Author So Young Park (Co-1st Author), Jouhahn Lee (Corresponding Author) Title Title **Representative Research Representative Research** Inorganic Micelles(Hydrophilic Core@Amphiprotic Shell) for Multiple Applications Black Phosphorus (BP) Nanodots for Potential Biomedical Applications **Publications in Year 2015 Publications in Year 2015** (Oct. 14, 2015) (Nov. 20, 2015) Journal Journal Advanced Functional Materials (IF:11.805) Small (IF: 8.368) Authors Authors Md. Shahinul Islam (1st author, KBSI), Won San Choi (Co-corresponding, Hanbat National Soon Chang Lee (Chungnam National Univ.), Saehae Choi (KRIBB), Soonjoo Seo (KBSI), Hy-Univ.), Sun Ha Kim (KBSI) & Oc Hee Han (KBSI) eran Kim (KBSI), Jonghan Won (KBSI), Kyuseok Choi (Kunsan National Univ.), Kyoung Suk Kang (KAIST), Hyun Gyu Park (KAIST), Hee-Sik Kim (KRIBB), Ha Rim An (KBSI), Kwang-Hun Abstract Jeong (Gachon Univ.), & Young-Chul Lee (Gachon Univ.) A facile approach for synthesizing superhydrophobic hollow silica micelles (SHSMs) with hydrophilic cores and amphiprotic (superhydrophobic/hydrophilic) shell structures that act as Abstract "all-in-one" smart nanomaterials has been developed. Due to the unique hydrophilic cores Recently, the appeal of 2D black phosphorus (BP) has been rising due to its unique optical and amphiprotic shells, the particles exhibit extraordinary performance in terms of amphiproand electronic properties with a tunable band gap. While numerous research efforts have tic catalytic reactions in organic and aqueous solutions, oil/water separation and pollutant recently been devoted to nano- and optoelectronic applications of BP, no attention has been purification, and an ultrahigh loading capacity of enzymes with significant stability and efpaid to promising medical applications. In this article, the preparation of BP-nanodots of ficient recyclability. a few nm to < 20 nm is reported by a modified ultrasonication assisted solution method. They showed no or little cytotoxic cell-viability effects in vitro involving blue- and green-flu-Expected Contribution to Science & Technology orescence cell imaging. Thus, BP-nanodots can be considered a promising agent for drug Due to the unique hydrophilic cores and amphiprotic shells, the SHSMs offer significant delivery or cellular tracking systems. technological promises in the fields of water remediation, clean up of oil spills, oil recovery, biosensing, drug delivery, and controlled release. Expected Contribution to Science & Technology In this work, we demonstrate that black phosphorus (BP) possess biocompatibility fluorescent emission, indicating that these BP-nanodots have great potential for biomedical applications including bioimaging, drug delivery, and cellular tracking.



SHSMs with hydrophilic core@amphiprotic shell (left) and AuNP-loaded SHSMs (right)



TEM images of SHSM-AuNP (left) and superhydrophobicity of SHSM-AuNP-coated metal meshes (right)







Cell bioimaging of BP-nanodots

INTERVIEW 2015 KBSI Researcher of the Year Award Winner

Dr. Hae Jin Kim

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Division of Environmental & Material Sciences

Dr. Hae Jin Kim from the Division of Environmental and Materials Analysis has been selected as the winner of 'KBSI Researcher of the Year', which is bestowed on the KBSI member with the most outstanding performance during the year.

He is recognized as the best in his field for making new paradigm by commending the research on 'Energy storage and catalysts using nanomaterial' with UAE and securing the strategic base for the cooperation of science and technology in the Middle East area.

You are honored as the 2015 KBSI Researcher of the Year. I think you have a special feeling regarding your accomplishment on international collaboration research with foreign researchers. Would you please tell us how you feel?

You successfully won the UAE international cooperation research project with full funding of 830,000 dollars for three years. Do you have special episodes or difficulties to share regarding the contents and procedures of the upcoming project?

This is a great honor and appreciation. I think we are able to continue our cooperative relationship because we put trust before individual accomplishments. This international collaborative research goes back to my post doctorate time in Slove-

nia about 20 years ago. I have researched with Dr. Gerogios Papavassiliou from NCSR Demokritos in Greece and Professor Dimitris Gournis from the University of Ioannina for 20 years as a multinational research group while visiting each other's countries. We supported each other by making up our missing pieces and we promoted the mutual exchange of opinions through annual research conferences. I believe these processes made today's results possible.

This collaborative research project is an alternative plan to compensate for future crude oil depletion in UAE, which is a powerful nation of natural energy resources with the 8th largest oil reserves and the 7th largest gas reserves in the world, and this project will be strategically investing on development of future technologies and nanocatalyst of the next-generation in order to resolve oil industry problems and remove harmful gases. The deposition problem of crude oil storage tanks has been the main reason for the decrease in crude oil mining and petroleum productivity as it interrupts the smooth flow of the crude oil pipeline. I will be leading the research on property analysis of nanomagnetic particles as well as development and characterization of new nanometal catalysts.

We usually have a video conference each week to discuss this international collaboration research project, but it is hard to organize the schedule because of time differences. We particularly had a trouble of making the last agreement due to delayed consent of the U.S.A. on the intellectual property rights.

And we were told a piece of congratulatory news that you won the creative research cooperation project at the end of last year.

We would like to ask you how the KBSI affected your research, and whether KBSI helped your study.

Lastly, please tell us about your research plans in 2016.

It is about developing a flexible shaped secondary battery as the next-generation secondary battery that could be wearable on clothes. It is such a distinguish study area for future technology. As we entered into the era of wearable electronics, more attention is given to the flexible lithium secondary battery as a promising source of electric power. It is especially a difficult research field requiring a lot of creativity due to the technology that uses the properties of nanomaterial. I expect that property analysis of materials, which is one of the strengths of our researchers, will play a very important role in this project.

I believe that KBSI brought me to where I am. Also, I always consider our research members as the best in the world. All of the foreign coworkers who visited our institute lifted their thumb up for the convenience and accessibility of our research facilities. Moreover, we have been invited to participate in a research group that is working with Max Planck Institutes in Germany and the national CNRS in France funded by EU, as the first non-EU member country. It implies that our researchers are highly evaluated, and I was so proud of KBSI.

ments in ongoing research projects. I will particularly focus on the field of energy storage using nanomaterial and catalysts. Also, I will try to start a project of building a joint research center with UAE to secure the strategic base camp for science and technology cooperation in Middle Eastern area. The research collaboration with UAE was adopted as the main agenda in the KOR-UAE Joint Committee on Science and Technology Cooperation last year. Scientific technologies of Korea such as a smartphone, nuclear power plant construction, and satellites are highly evaluated by Middle Eastern countries. Nowadays, the interest of Middle Eastern countries having plentiful oil reserves is shifting to the field of research and development from limited natural resources. But as their research facilities and infrastructures require more improvement, I hope we will continuously expand our relationship with Middle Eastern countries using our scientific technologies and infrastructures that we have accomplished in Korea. I expect that the energy R&D technology of Korea will greatly contribute to the development of energy industry in the materials area of Middle Eastern countries.





First of all, I wish a healthy year. And I will make an effort to accomplish many achieve-

KOREA BASIC SCIENCE INSTITUTE

2015

ANNUAL REPORT

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