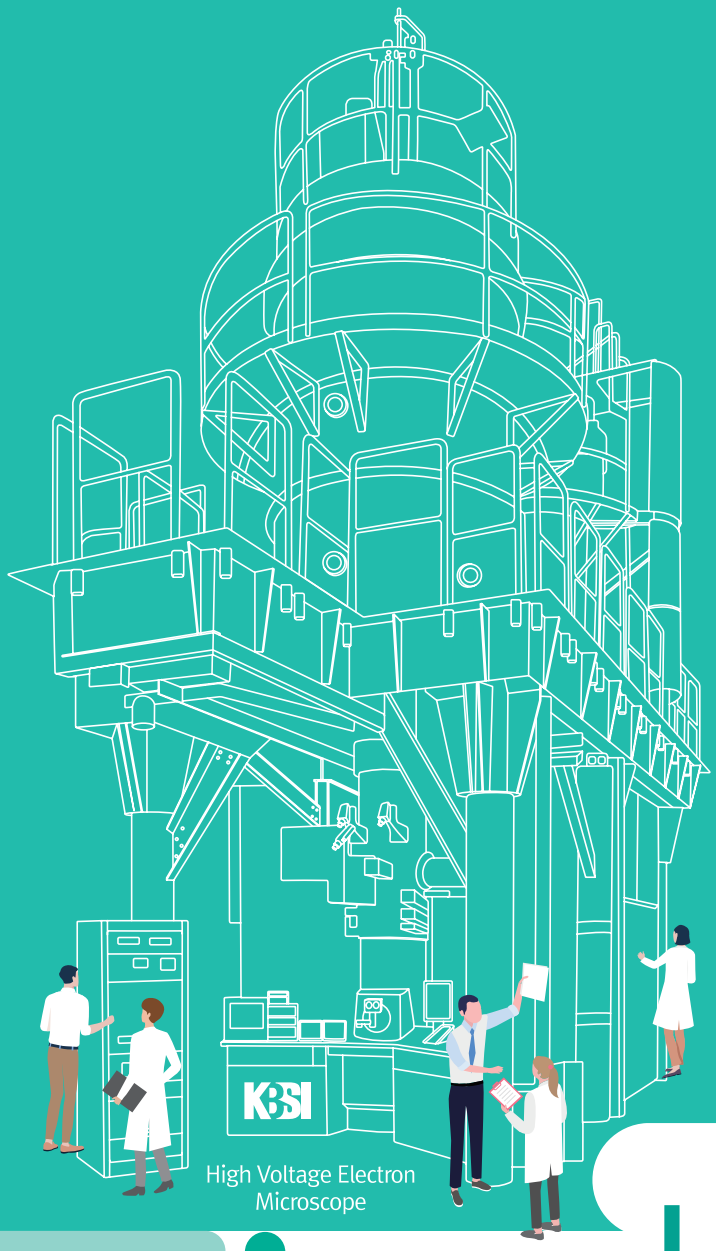


High Voltage Electron Microscope

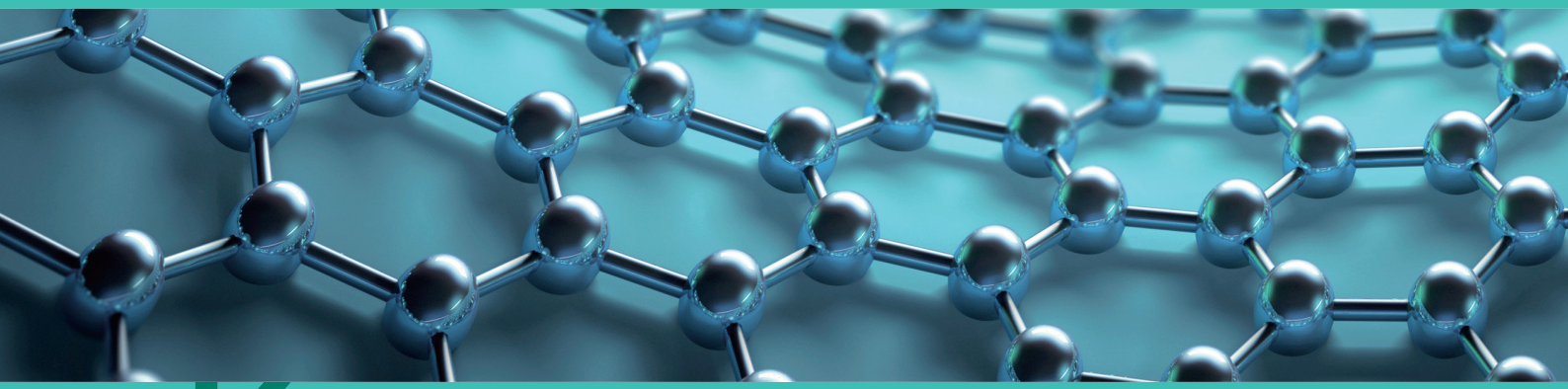
Leading the Innovation of Advanced Science

World-Class Research Infrastructure

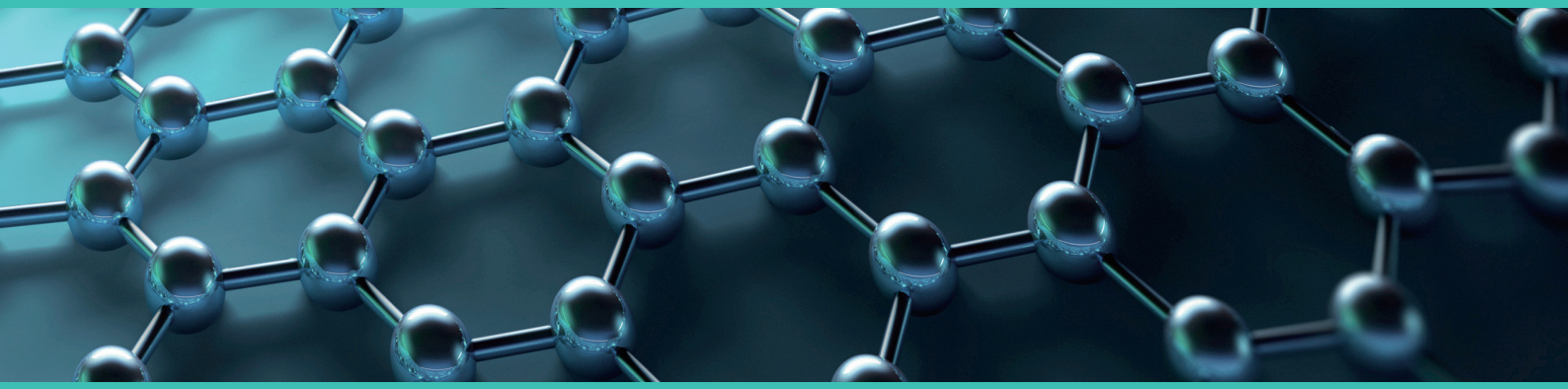
KBSI

Leading-edge Equipment

KBSI KOREA BASIC SCIENCE INSTITUTE



Korea Basic Science Institute

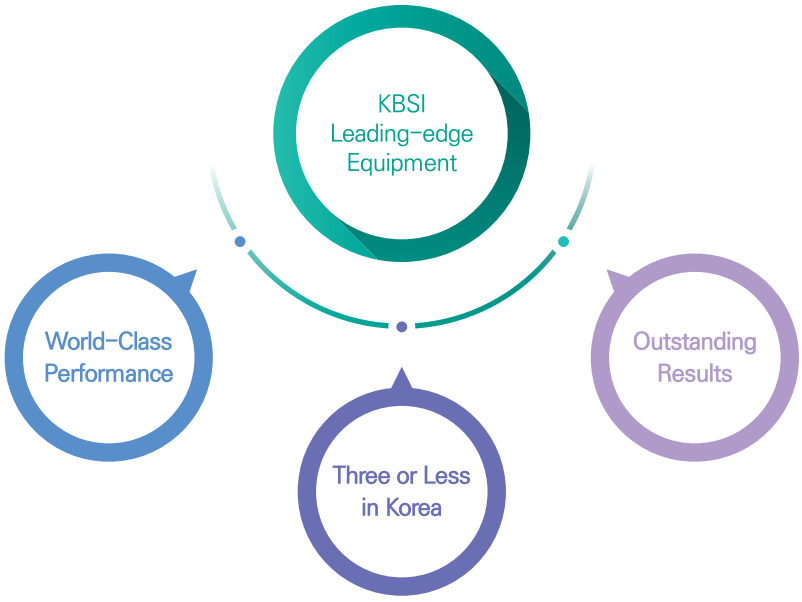


CONTENTS

KBSI Leading-edge Equipment

KBSI Leading-edge Equipment is research equipment presenting **world-class performance and specifications** that can produce outstanding results **among the only three or less** available equipment in Korea.

KBSI utilizes leading-edge equipment
to implement customized support programs for each user group.



Projects Support Program

- Calls for proposals twice a year (fast track also available)
- Discounted equipment charges
- Problem-solving short-term projects

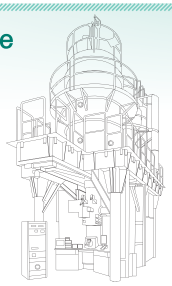
Users Support Program

- Intensive program
- Equipment charges and travel expenses provided
- Calls for proposals once a year
- Long-term projects aiming for outstanding outputs
- (Domestic) Senior researchers/Junior researchers/ Outstanding users tracks
- (International) Global scientists track

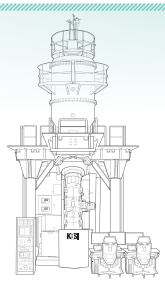
Joint Utilization of KBSI Leading-edge Equipment

Introduction to KBSI Leading-edge Equipment

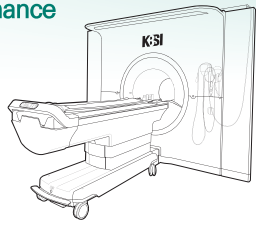
High Voltage Electron Microscope (HVEM)



Bio-High Voltage Electron Microscope (Bio-HVEM)

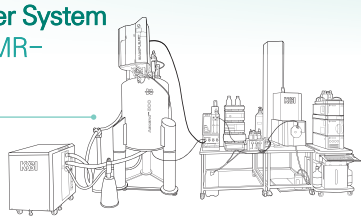


7 T Human Magnetic Resonance Imaging System (7 T Human MRI System)

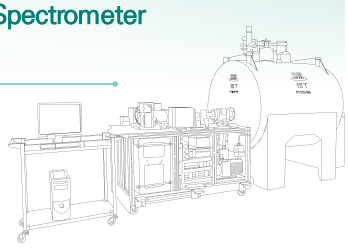


900 MHz Nuclear Magnetic Resonance Spectrometer (900 MHz NMR)

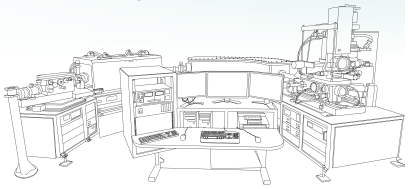
SPE-800 MHz Nuclear Magnetic Resonance-Mass Spectrometer System (SPE-800 MHz NMR-MS System)



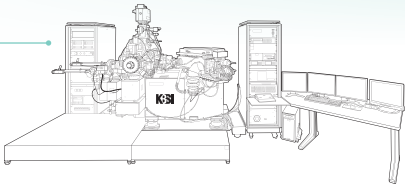
15 T FT-ICR Mass Spectrometer (15 T FT-ICR MS)



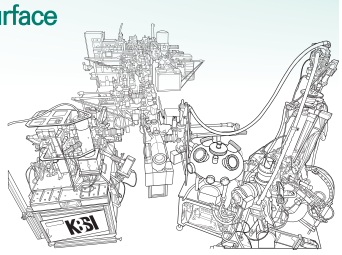
High-Resolution Secondary Ion Mass Spectrometer (SHRIMP)



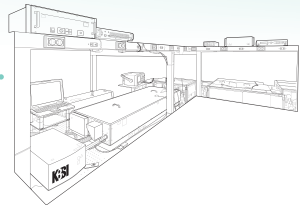
Nano Secondary Ion Mass Spectrometer (Nano-SIMS)



Advanced In-situ Surface Analysis System (AiSAS)



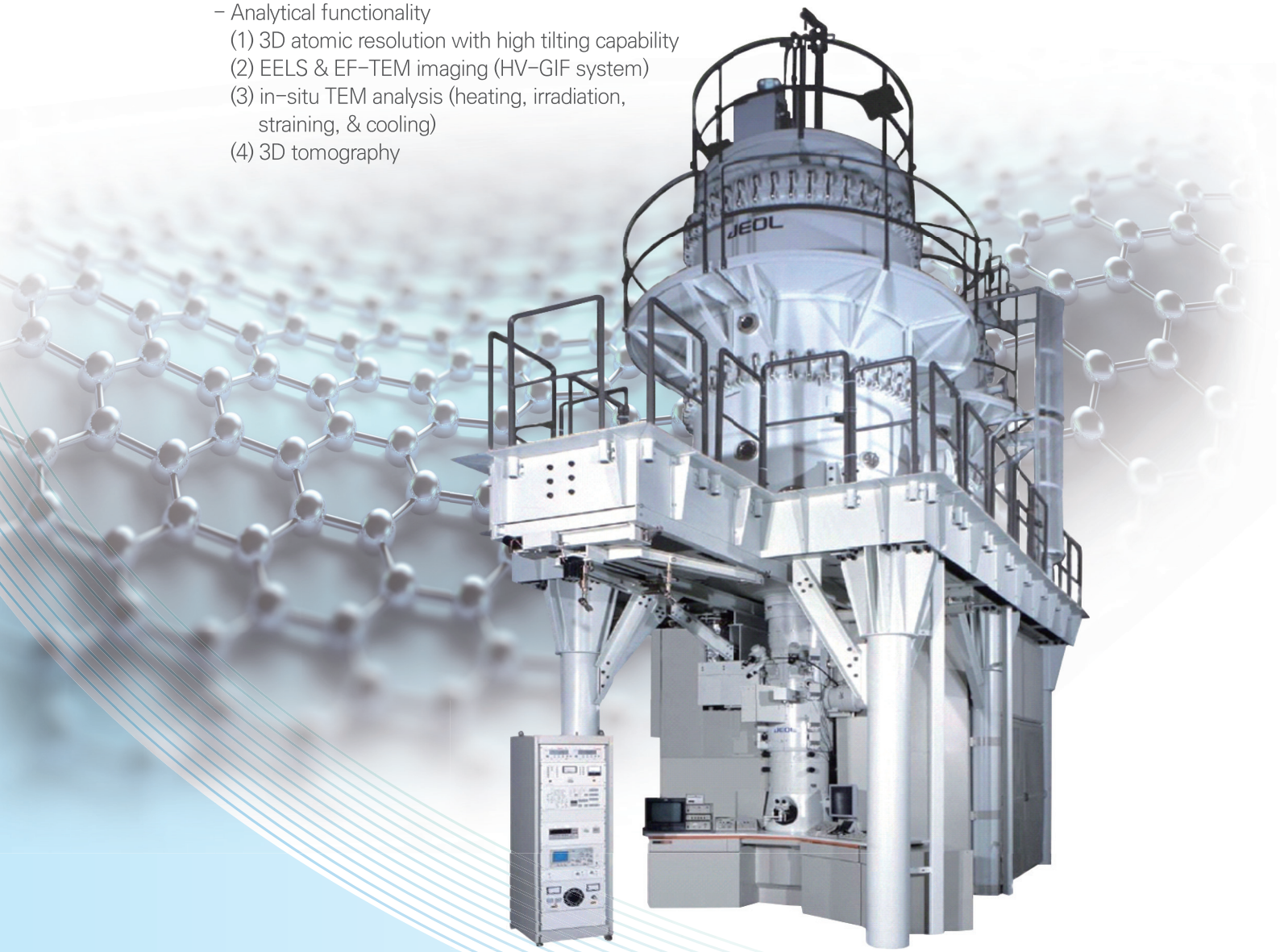
Femtosecond Multi-dimensional Laser Spectroscopic System (FMLS)



High Voltage Electron Microscope

Model_ JEM-ARM1300S

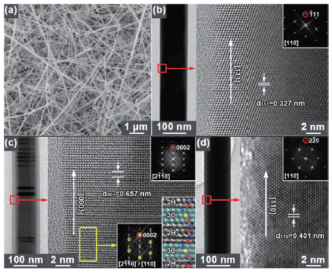
- Accelerating voltage: 1,250 kV
- Point resolution: 0.12 nm
- Specimen tilt angle: α = ±60°, β = ±45°
- Post column type Gatan Image Filter
- Analytical functionality
  (1) 3D atomic resolution with high tilting capability
  (2) EELS & EF-TEM imaging (HV-GIF system)
  (3) in-situ TEM analysis (heating, irradiation, straining, & cooling)
  (4) 3D tomography



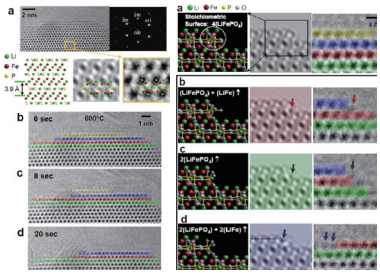
| 169-148, Gwahak-ro, Yuseong-gu, Daejeon, 34133, Republic of KOREA
| Seung Jo Yoo (Center for Research Equipment)
| +82-42-865-3622
| Instrument code: AE01
| sjyoo78@kbsi.re.kr

Applications and Features

- 3D observation of the atomic structure of materials by simultaneously implementing atomic-resolution power (〈0.12 nm) and a high tilt angle (±60°)
- Implementing the chemical signal detection function with a high collection rate using a state of the art energy filter (HV-GIF) mounted to utilize the relativity effect
- In-situ TEM study with particularly manufactured specimen holders



Atomic structure analysis of the nano materials



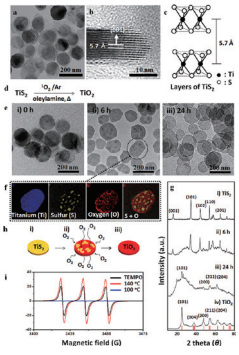
Real-time structure analysis at high temperature

Representative Research Achievement

➤ **Identification of the shape control processes of nanostructured materials via the atomic resolution of HVEM**

Analysis of the atomic structure and shape control mechanism of a 2D layered TiS_2 nanocrystal by direct atomic and chemical structure imaging

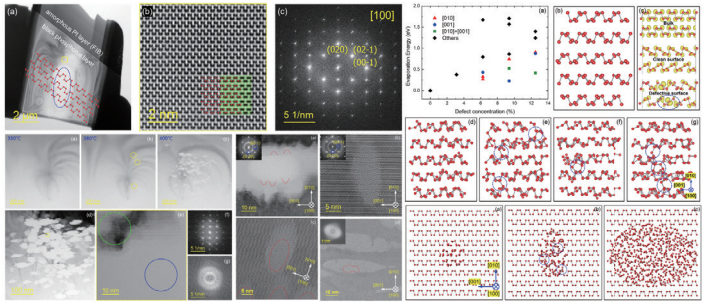
Journal of American Chemical Society, Vol. 135, 2013



➤ **Investigation of the initial thermal behavior of black phosphorus by conducting in-situ heating experiments in an HVEM**

Direct observation of the initial thermal disorder and decomposition of layered black phosphorus at the atomic level confirmed that the surface defects acted as the initiators of the decomposition reaction during its initial thermal behavior.

Nanotechnology, Vol. 29, 2018

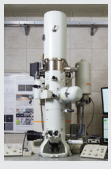


Related Instruments

Ultra high resolution Cs-Corrected Transmission Electron Microscope (Mono Cs-TEM)

- Model: Monochromated JEM-ARM200F (JEOL)
- Acceleration voltage: 30 ~ 200 kV
- STEM resolution: 0.08 nm (at 200 kV/mono off)
- Tilting angle: ±25°
- Related equipment: HAADF, ABF, and BF detectors
- EELS resolution: 25 meV (at 60 kV) and 36 meV (at 200 kV)

Field Emission Transmission Electron Microscope (FE-TEM)



- Model: JEM-2100F (JEOL)
- Acceleration voltage: 200 kV
- Point resolution: 0.19 nm
- STEM resolution: 0.15 nm
- Tilting angle: α = ±25° and β = ±25°
- Temperature: -196° ~ room temperature

Ultra-Corrected Energy-Filtered Transmission Electron Microscope (UC-EF-TEM)

- Model: Libra 200 HT Mc (Carl Zeiss)
- Acceleration voltage: 200 kV
- Point resolution: 0.13 nm
- STEM resolution: 0.32 nm
- Energy resolution: 0.15 eV
- Tilting Angle: α = ±70° and β = ±30°

Focused Ion Beam (FIB)

- Model: Quanta 3D FEG (Thermo Fisher)
- Acceleration voltage: 200 V to 30 kV
- Point resolution: 1.2 nm at 30 kV (SE) and 2.5 nm at 30 kV (BSE)
- Magnification: ×10 ~ ×1,200,000
- Prove current: 1 pA to 65 nA in 15 steps
- Ion source: Ga liquid metal
- Ion beam resolution: 7 nm at 30 kV

Bio-High Voltage Electron Microscope

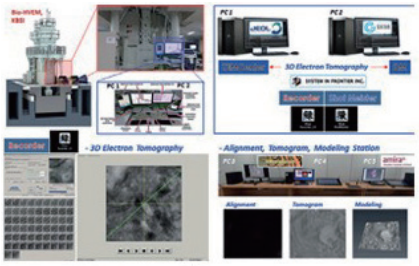
Model_ JEM-1000BEF

- Acceleration voltage: 1,000 kV
- Point resolution: 0.15 nm
- STEM resolution: 2.0 nm
- Analytical functionality:
  (1) 3D RT/Cryo-electron tomography
  (2) Large area panorama imaging
  (3) Thick bio/nano-specimen imaging with high contrast
  (4) In-column Ω energy filter

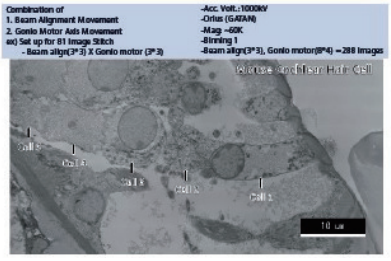
| 162 Yeongudanji-ro, Ochang, Cheongwon-gu, Cheongju, Chungbuk 28119, Republic of Korea
| Instrument code: OC101
| Hee-Seok Kweon, Eunyoung Moon (Center for Research Equipment)
| +82-43-240-5440, +82-43-240-5446
| hskweon@kbsi.re.kr,mey0916@kbsi.re.kr

Applications and Features

- 3D modeling of cell organelles by a high tilting (±70°) function and at a high resolution (0.15 nm)
- RT/Cryo-3D electron tomography (≥1 ㎛ thickness of sample)
- Analysis of a large area with a high resolution using the limitless panorama function
- High-resolution contrast-enhanced imaging using a high accelerating voltage (1,000 kV)/in-column energy filter



3D ultrastructural analysis of thick (≥1 ㎛) bio-nanomaterials using electron tomography



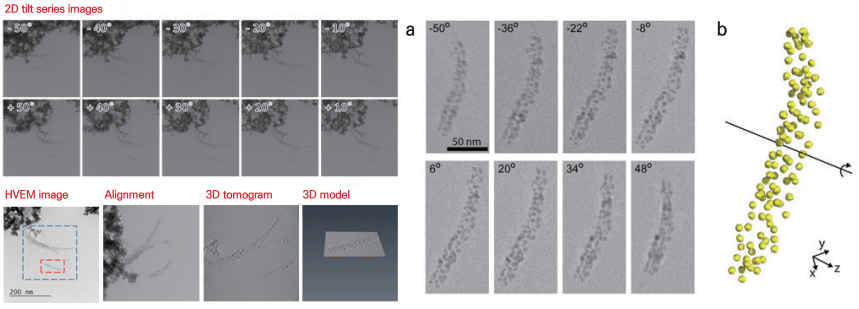
3D large-area analysis of bio-nanomaterials using the limitless panorama function

Representative Research Achievement

➤ **3D reconstruction and modeling of a helical assembly of nanoparticles by a Bio-HVEM analytical system**

3D reconstruction of a peptide programmable nanoparticle superstructure via 3D electron tomography using a Bio-HVEM system.

ACS Nano, Vol.12, 2018



The tilt series of AuPt/HC/SWNT superstructure images were recorded with an interval of 2° via electron tomography using a bio-HVEM system. A 3D tomogram and a model were sequentially reconstructed from the aligned tilt series images.

Related Instruments

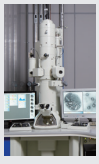
High-resolution Bio-Transmission Electron Microscopy (HR Bio-TEM)

- Model: Titan Krios (Thermo Fisher)
- Acceleration voltage: 80 ~ 300 kV
- Point resolution: 0.27 nm
- Magnification: ×40 ~ ×740,000
- Tilting angle: ±70° (90° in-plane rotation)
- Temperature: −196°C ~ room temperature
- Related equipment: Specimen autoloader, Cryo-EM System, DED (4k), Volta phase plate, Cs image corrector, STEM, and Tomography system

Energy Filtering Cryo-Transmission Electron Microscope (EF Cryo-TEM)

- Model: Talos Arctica G2 (Thermo Fisher)
- Acceleration voltage: 200 kV
- Electron source: X-FEG
- Information limit: ≤0.23 nm
- Temperature: −196°C
- Tilting angle: ±70°
- Related equipment: Gatan K3, Gatan BioQuantum (energy filter), Micro-ED suite, Phase plate, and Tomography system

Cryo-Transmission Electron Microscopy (Cryo-TEM)



- Model: JEM-1400Plus (JEOL)
- Acceleration voltage: 120 kV
- Point resolution: 0.38 nm
- Magnification: x 10 ~ x 1,200,000
- Tilting angle: ±80° (Gatan 914 High Tilt Holder)
- Temperature: −196°C ~ room temperature
- Related equipment: Cryo-EM system, Tomography system, and Bottom CCD (4k)

Focused Ion Beam (FIB)

- Model: Quanta 3D FEG (Thermo Fisher)
- Acceleration voltage: 200 V to 30 kV
- Point resolution: 1.2 nm at 30 kV (SE), 2.5 nm at 30 kV (BSE)
- Magnification: ×10 ~ ×1,200,000
- Prove current: 1 pA ~ 65 nA in 15 steps
- Ion source: Ga liquid metal
- Ion beam resolution: 7 nm at 30 kV
- Related equipment: Cryo-transfer system

7 T Human Magnetic Resonance Imaging System

Model_ Philips Achieva 7.0T

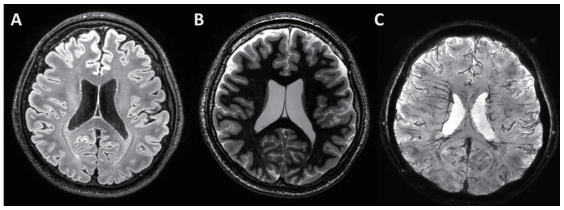
- Actively shielded compact magnet: field strength: 7.0 T (human, primate, animals)
- Gradient system: max. amp. 40 mT/m and slew rate 200 mT/m/ms
- RF coil system: head 8Tx/32Rx, knee 1Tx/28Rx, wrist, and small-animal multi-nuclei head (^{31}P/^{1}H, ^{13}C/^{1}H, and ^{23}Na/^{1}H)
- High-order B0 shimming system: 3rd-order and 13-component
- B1 shimming system: built-in (quad/pre-defined ROI) and user-defined algorithm

| 162 Yeongudanji-ro, Ochang, Cheongwon-gu, Cheongju, Chungbuk 28119, Republic of Korea | Instrument code: AR72
| Dr. Chulhyun Lee (Center for Research Equipment) | +82-43-240-5090 | chulhyun@kbsi.re.kr

Applications and Features

- High-sensitivity and high-resolution brain micro-structures
- Imaging diagnosis of brain diseases and functions
- Research on degenerative arthritis of knees, wrists, and foot ankle
- RF safety research
- Mid- and large-sized animal imaging

8CH Head pTx Coil
8×1kW

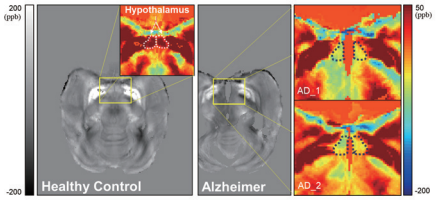


A FLAIR (MPR), 0.5×0.5×0.5mm^3 (3D), 9 min 4 s
B WMS (White Matter Suppressed) (MPR), 0.8×0.8×0.5mm^3 (3D), 8 min 51 s
C SWI (minIP), 0.5×0.5×5mm^3, 6 min 38 s

Representative Research Achievement

➤ Development of an MR image biomarker for a primate disease model using ultra-high-field MRI

- Multi-parametric biomarker development for the disease model of a primate Alzheimer
- Utilization of ultra-high-field characters: high magnetic susceptibility, wide chemical shift (in Hz), and long T1 relaxation time
- Optimization of the imaging techniques for susceptibility, CEST, and T1- and T2-weighted images
- Establishment of a multi-parametric diagnostic method based on the deep-learning technology

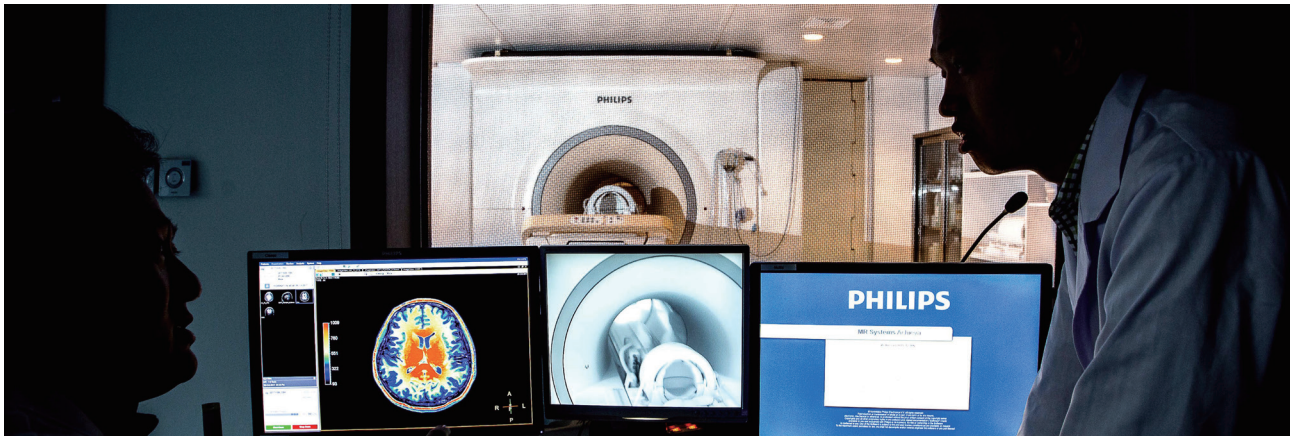


Comparison of the quantitative susceptibility distribution of the images of a normal primate and Alzheimer's disease model primate, particularly in the hypothalamus region

Related Instruments

3 T Human Magnetic Resonance Imaging System

- Model: Philips Achieva 3.0T TX
- Magnetic field strength: 3.0 T
- Gradient: amplitude 80 mT/m and slew rate 200 T/m/s (b-value ~ 25,000)
- RF coil package: 32CH SENSE head/torso/cardiac, 8CH SENSE head/knee/spine, and flexible loop array



900 MHz Nuclear Magnetic Resonance Spectrometer

Model_ AVANCE NEO 900

- Magnet: 21.1 Tesla
- Probe: 1H- {^{13}C/^{15}N}XYZ-G cryogenic probehead
- ^{1}H sensitivity 10,000:1 w/ 0.1% EB
- ^{13}C sensitivity 1449:1 w/ASTM
- 4 channels

| 162 Yeongudanji-ro, Ochang, Cheongwon-gu, Cheongju, Chungbuk 28119, Republic of Korea
| Instrument code: AR91
| Cheong Hae-Kap, Kim Eunhee, Ryu Kyeong-Seok (Center for Research Equipment)
| 043-240-5062~5064
| haekap@kbsi.re.kr, keh@kbsi.re.kr, ksryu@kbsi.re.kr

Applications and Features

- Structural analysis of protein and natural products
- Protein-protein interaction and dynamics
- Screening of lead discovery and metabolomics
- The cryogenic probehead is four times more sensitive (8,000) than the proposed RT probeheads and can reduce the experiment time by 1/16
- Up to 100 μM of protein sample
- Up to 100 μg of natural product of ^{13}C experiments

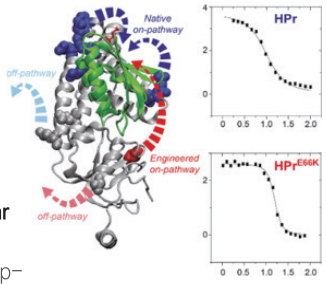
Representative Research Achievement

➤ Visualization of the target search process using PRE NMR

Visualization of the searching process of the HPr protein to the N-terminal domain of Enzyme I and demonstration that the protein-protein interaction speed can be improved by studying the protein target searching mechanism

Structure, Vol.26, 2018

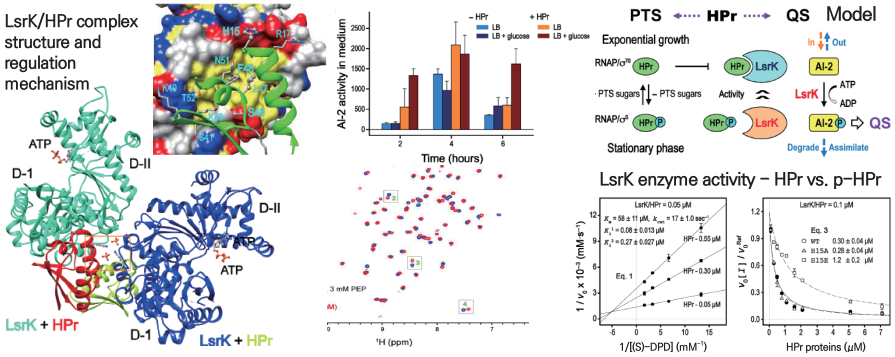
Native and *Engineered* target search process



➤ Evidence of the relation between quorum sensing and sugar metabolism in Escherichia coli

Identification of the LsrK enzyme activity regulation by HPr/p-HPr in AI-2-dependent quorum sensing

Science Advances, Vol. 4, 2018



Related Instruments

800 MHz NMR Spectrometer

- Model (manufacturer): AVANCE III HD 800 (Bruker)
- Magnet: 18.8 T
- Probe: ^{1}H-{^{13}C/^{15}N}Z-G cryogenic probehead
- ^{1}H sensitivity: 8743:1 w/0.1% EB
- ^{13}C sensitivity: 1749:1 w/ASTM
- Automatic sample changer (24 ea)

700 MHz NMR Spectrometer

- Model (manufacturer): AVANCE III HD (Bruker)
- Magnet: 16.45 T
- Probe: ^{1}H-{^{13}C/^{15}N}Z-G cryogenic probehead
- ^{1}H sensitivity: 7963:1 w/0.1% EB
- ^{13}C sensitivity: 1481:1 w/ASTM
- Automatic sample changer (24 ea)

Auto Isothermal Titration Calorimeter

- Model (manufacturer): MicroCal Auto-iTC200 (GE Healthcare)
- Minimum sample amount: 0.6 nmol
- Response time: 10 s
- Stirring rate: 500 ~ 1500 RPM (user selectable)
- Noise level: 0.5 ncal/s

Multi-angle Light Scattering System (MALS)

- Model (manufacturer): DAWN HELEOS II (Wyatt Technology)
- Detectors: 18 angles
- Molar mass range: ⟨103 to 109 g/mol
- Molecular size range: ~10 to 500 nm
- Differential refractometer (RI detector)

SPE-800 MHz Nuclear Magnetic Resonance-Mass Spectrometer System

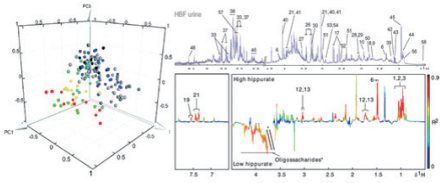
Model_ 800 MHz Ascend™

- 18.89 T actively shielded superconducting magnet
- Cryogenic probe
  (^{1}H sensitivity = 8189:1 and 0.1% EB in $CDCl_3$ (2-ppm noise))
- SampleJet (Automatic sample change system, 480 samples)
- LC-SPE-NMR/MS system

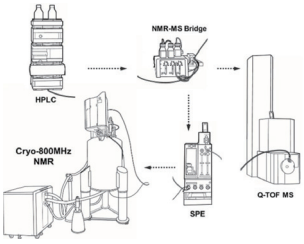
| University-Industry Cooperate Building, 150 Bugahyeon-ro, Seodaemun-gu, Seoul 03759, Republic of Korea
| Instrument code: WS003 | Geum-Sook Hwang, Youngae Jung, Jueun Lee (Western Seoul Center)
| +82-2-6908-6200, +82-2-6908-6233, +82-2-6908-6256 | gshwang@kbsi.re.kr, jya0819@kbsi.re.kr, lje3080@kbsi.re.kr

Applications and Features

- Animal/plant/microbial/environmental metabolomic profiling and biomarker discovery
- New compound discovery and drug identification
- Separation of natural products and structural elucidation
- Discovery of useful metabolites and analysis of synthetic pathways
- Construction and standardization of a life resource database
- Integrated analytical system in various fields, such as metabolite identification and metabolism elucidation
- It is used to identify the structures of compounds via high-sensitivity cryogenic 800-MHz NMR and UPLC-QTOF MS after separating the mixture by LC



Metabolic biomarker and signature discovery by integrated metabolic profiling analysis



Identification of natural product mixtures using an LC-SPE-NMR/MS hyphenated system

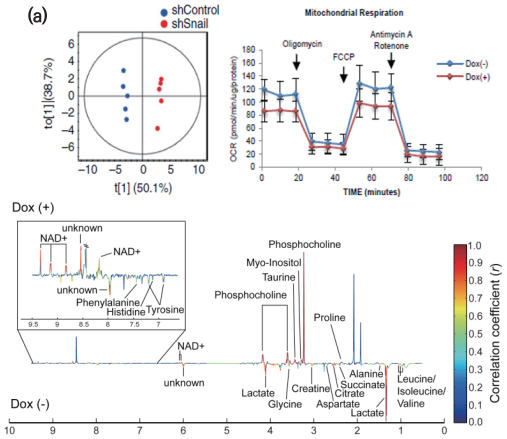
Representative Research Achievement

➤ Metabolic profiling analysis and metabolism elucidation in cell/blood tissue samples

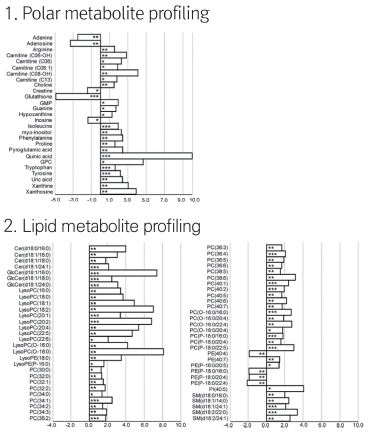
- Identification of the glucose metabolism associated with cancer cell survival under a metabolic stress by metabolic profiling analysis

  Nat. Commun, Vol.8, 2017
- Identification of disease metabolism and discovery of a potential biomarker by metabolic profiling analysis of aorta tissues from patients with arteriosclerosis

  Atherosclerosis, Vol.269, 2018



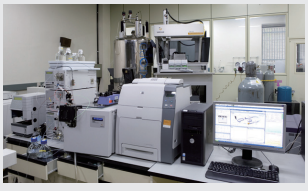
(a) Identification of the metabolism associated with cancer cell survival via NMR spectroscopy



(b) Polar and lipid metabolic profiling analysis in aorta tissues from patients with arteriosclerosis

Related Instruments

Online liquid chromatography-mass spectrometry-nuclear magnetic resonance spectroscopy hyphenated system



- Model (manufacturer): NL/450 GC (Varian)
- ^{13}C-enhanced salt-tolerant cold probe
- ^{1}H{^{13}C/^{15}N} with PGF (1H S/N: 4600:1, ^{13}C S/N: 500:1)
- LC-NMR (flow kit) module (S/N ratio 256:1, line shape (0.55%) 7.7 Hz)
- Integrated LC-NMR/MS system supporting flow and stop flow experiment
- Ultra-high-throughput robotics system

15 T FT-ICR Mass Spectrometer

Model_15T solariX XR

- Resolution: 〉10,000,000(at Narrowband)
- Sensitivity: S/N = 86 at Ubiquitin 100 attomol
- Mass range: m/z 100 ~ 3000
- Ionization method: MALDI, ESI, APCI, APPI
- MS/MS mode: CID, ECD, ETD, ISD
- Magnet: 15-Tesla Superconducting Magnet

| 162 Yeongudanji-ro, Ochang, Cheongwon-gu, Cheongju, Chungbuk 28119, Republic of Korea | Instrument code: ICR02
| Jang, Kyoung-Soon (Center for Research Equipment) | +82-43-240-5196 | ksjang@kbsi.re.kr

Applications and Features

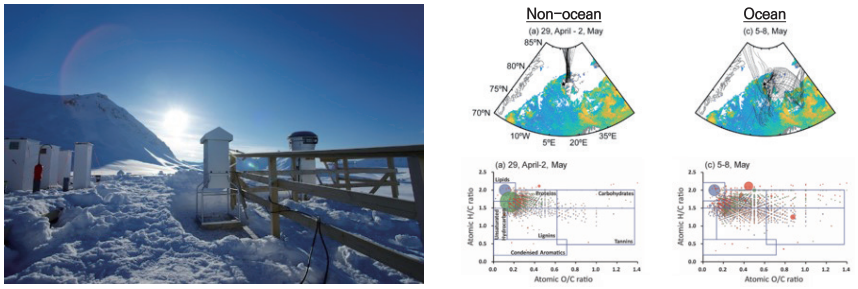
- Highly accurate mass measurement and profiling using ultra-high-resolution mass spectrometry
- Ultra-high mass resolution (>10,000,000) achieved using a world-class 15-T superconducting magnet
- MALDI and ESI available
- Molecular imaging, multi-dimensional LC/MS/MS (optional)
- APCI, APPI ionization techniques, and tandem MS techniques (CID, ECD, ETD, and IS-CAD) available

Representative Research Achievement

➤ Development of an advanced platform for the characterization of fine aerosol ($PM_{2.5}$)-derived organic substances via ultra-high-resolution mass spectrometry

To overcome the health-threatening domestic fine air pollution problem and understand the chemical composition and formation mechanism of fine aerosols in the Arctic related to climate change, the chemical and molecular compositions of PM2.5-derived organic compounds were characterized using a 15-T FT-ICR mass spectrometer (the National Strategic Project on Fine Particles).

Global Biogeochemical Cycles, Vol. 33, 2019

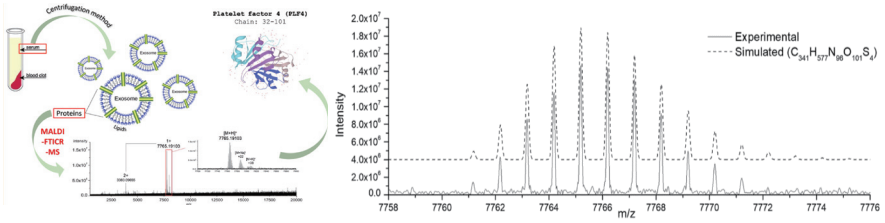


High-volume aerosol sampler installed at the Arctic Research Center (left), and Arctic airmass back trajectory analysis, ocean chlorophyll concentrations, and FT-ICR MS-based molecular features of the Arctic $PM_{2.5}$-derived organic constituents (right)

➤ Identification of human-blood-derived exosome-specific protein marker

Exosome-specific platelet factor 4 protein was identified using a 15-T FT-ICR mass spectrometer.

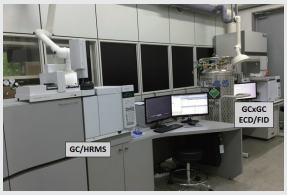
Analytical Chemistry, Vol.91, 2019



Isolation of exosomes from human blood and identification of exosome-specific platelet factor 4 marker protein

Related Instruments

Two-dimensional Gas Chromatography/High-resolution Mass Spectrometer System



- Model (manufacturer): Pegasus 4D GC×GC-TOFMS (Leco)
- Ionization mode: EI and CI
- Mass range: 10 ~ 1,500 u at any acquisition rate
- Mass resolution: 25,000 at m/z 218.98
- Dynamic range: 5 orders of magnitude or more
- Spectral acquisition rate: 1 ~ 200 spectra/s
- Mass accuracy: < 5 ppm

High-Resolution Secondary Ion Mass Spectrometer

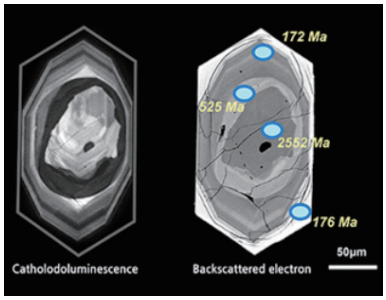
Model_ SHRIMP-IIe/MC

- Primary ion: Cs^+, O^-, O_2^-
- Mass Range: 6 ~ 300 amu
- Detection limit: 1 ppm with 10,000 mass resolution and 50% transmission
- Speciality: U-Pb geochronology, The first high-resolution secondary ion mass spectrometer in Korea

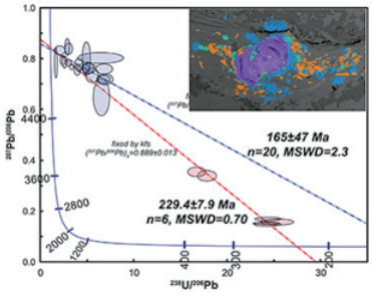
| 162 YeonguDanji-ro, Ochang, Cheongwon, Cheongju, Chungbuk 28119 | Instrument code: GT01
| Dr. Keewook Yi, Shinae Lee (Center for Research Equipment) | +82-43-240-5175, +82-43-240-5172
| kyi@kbsi.re.kr, lsa2011@kbsi.re.kr

Applications and Features

- U-Pb age dating of heavy minerals
- Trace element analysis
- KBSI SHRIMP is the first high-resolution secondary ion mass spectrometer in Korea
- It has a low detection limit (~1 ppm) with 10,000 mass resolution and 50% transmission
- Multi-collection system with charge-mode electrometers can measure Pu isotopes simultaneously



U-Pb geochronology



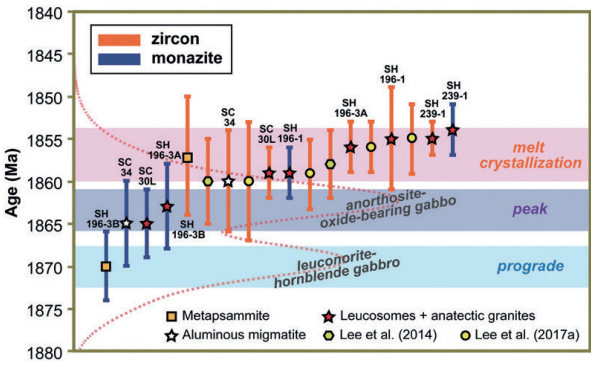
In-situ isotopic measurement of microtexture

Representative Research Achievement

➤ **Prolonged high-temperature, low-pressure metamorphism associated with ~1.86 Ga Sancheong-Hadong anorthosite in the Yeongnam Massif**

SHRIMP U-Th-Pb ages of zircon and monazite from migmatitic gneisses in the Sancheong-Hadong area, Yeongnam Massif showed that the high-temperature, low-pressure metamorphism associated with anorthosite persisted over a period of ~15 Ma. This corresponded to the last stage of Paleoproterozoic (~1.95-1.85 Ga) hot orogenesis in the North China Craton.

Precambrian Research, Vol 307, 2018



➤ **In-situ oxygen isotope records of crustal self-cannibalization selectively captured by zircon crystals from high-δ^{26}Mg granitoids**

Investigation of the arc magmatism of juvenile crust by isotope analysis of zircon mineral texture

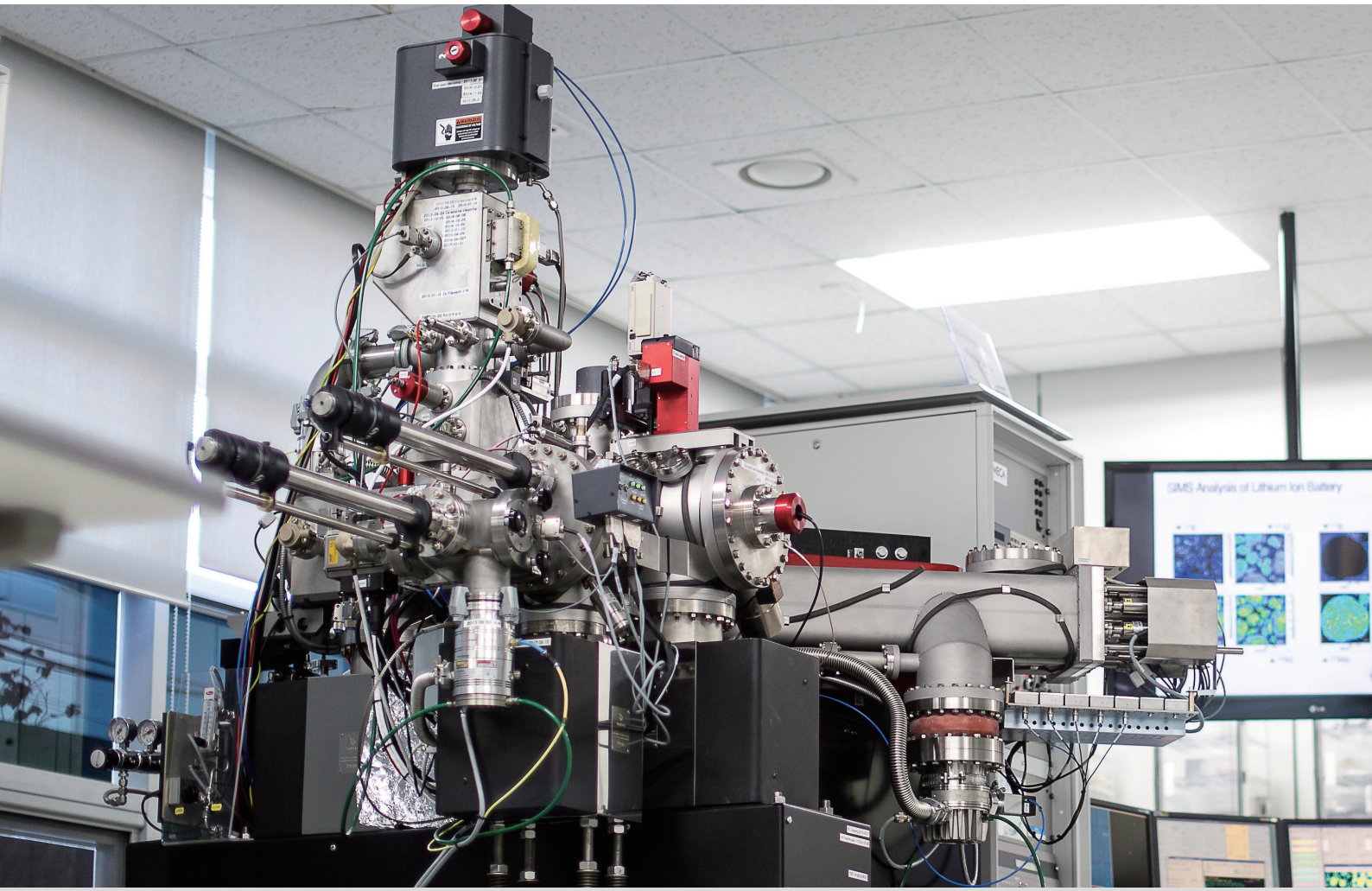
Geology, Vol.44, 2016

Related Instruments

Laser Ablation-Multi Collector-Inductively Coupled Plasma Mass Spectrometer

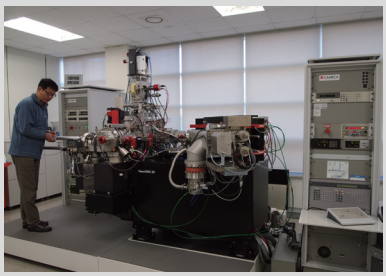
- Model: Nu plasma II (Nu Instruments)
- 193-㎚ laser with 〈 4-ns pulse width
- 1 ~ 300 ㎐ repetition rate
- 12 J/cm^2 fluence at the sample surface
- 13 "true aperture imaged" spots between 2 and 150 microns.
- Infinitely variable aperture (IVA)-imaged spot size selection between 2 and 110 microns, in 1-micron steps.

Nano Secondary Ion Mass Spectrometer



Model_ NanoSIMS 50

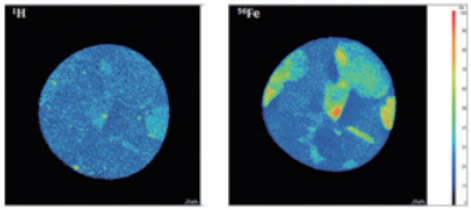
- Primary ion source (beam size): Cs^+ (50 ㎚), O_2^+ and O^- (200 ㎚)
- Mass Range: 1 ~ 360 amu (H ~ U)
- Detection limits: ppb ~ ppm levels
- Speciality: optimized for high lateral resolution (50 ㎚) with high mass resolution and high sensitivity including hydrogen



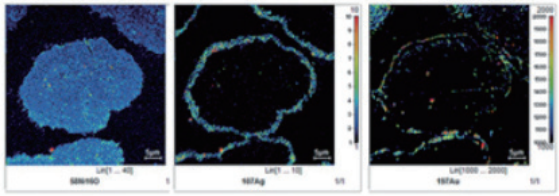
| 60 Gwahaksandan 1-ro, Gangseo-gu, Busan 46742, Republic of Korea
| Instrument code: PH405
| Mirang Byeon, Tae-Eun Hong (Busan Center)
| +82-51-974-6119. +82-42-865-3684
| bmr12@kbsi.re.kr, tehong@kbsi.re.kr

Applications and Features

- Element distribution analysis of cathode, anode materials for lithium ion batteries
- Depth profiles of impurities in the micro patterns for semiconductors
- Element distribution analysis of grain boundary segregation in steel
- High sensitivity imaging of light elements (including hydrogen)



NanoSIMS image acquisition of hydrogen in TWIP Steel



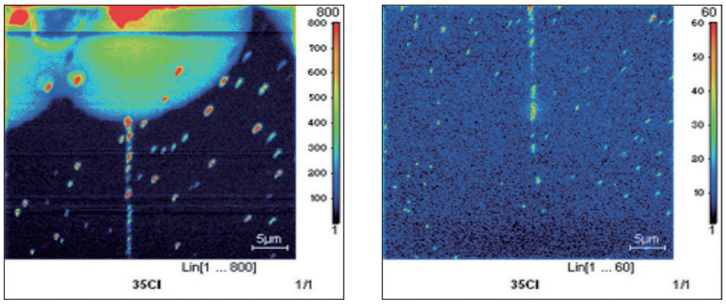
NanoSIMS image acquisition of Ag- and Au-coated Ni powder

Representative Research Achievement

A study of cation transfer phenomena using a nano secondary ion mass spectrometer

NanoSIMS was utilized to investigate selective proton transport on the surface of single-walled carbon nanotubes depending on the application of an electric field on the surface as well as the transport control mechanism.

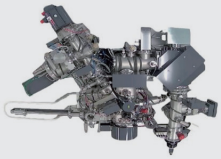
Chem. Mater. Vol.30 (2018)



A NanoSIMS ion image of chlorine on a single-walled carbon nanotube

Related Instruments

Secondary Ion Mass Spectrometer

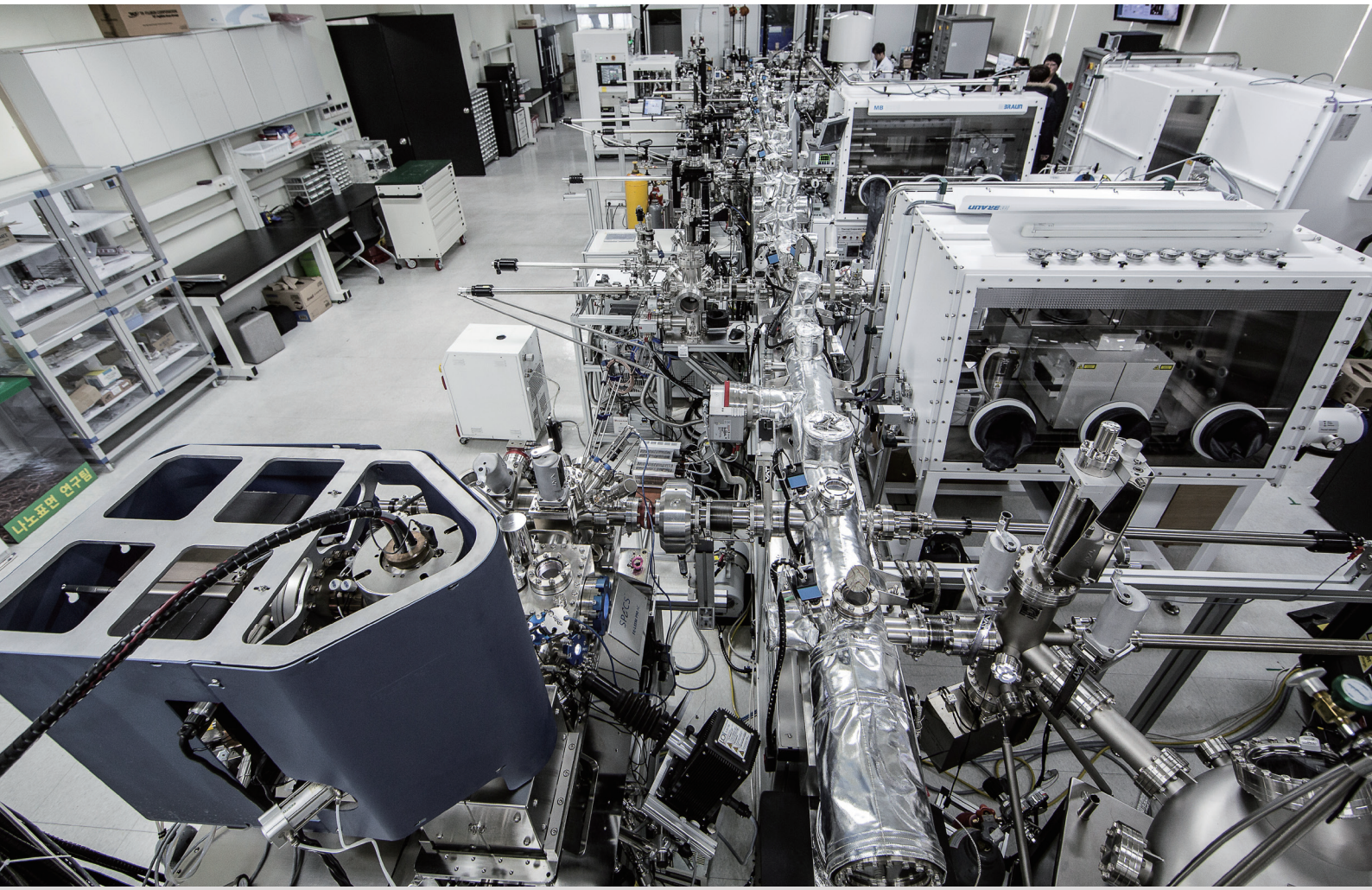


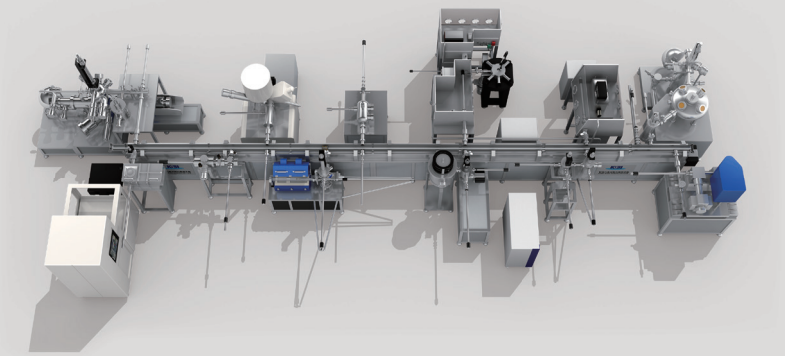
- Model: ims-7f auto, ims-6f
- Primary ion: Cs^+, O_2^+, and O^-
- Impact energy: $Cs^{+/-}$: 2-20 keV and O_2^+/O^-: 0.5-10 keV
- Mass range: 1 ~ 360 amu (H ~ U)
- Detection limits: ppb ~ ppm levels
- Options: post-accel/decel, rotation stage, and RAE detector for imaging analysis

Atomic Force Microscope

- Model: Nanowizard II
- Resolution: noise lever RMS: ⟨0.03 nm RMS, vertical resolution: 0.01 nm, and lateral resolution: 0.1 nm
- Scan range: lateral scan area: 100 ㎛ × 100 ㎛ and vertical range: 15 ㎛
- Scan rate: contact mode (max): 3 ~ 5 Hz and non-contact mode: 1 ~ 3 Hz

Advanced In-situ Surface Analysis System (AiSAS)





169-148 Gwahak-ro, Yuseong-gu, Daejeon, 34133, Republic of Korea
Beomgyun Jeong, Cheolho Jeon (Research Center for Materials Analysis)
bjeong@kbsi.re.kr, cjeon@kbsi.re.kr
Instrument code: QM12
+82-42-865-3676, +82-42-865-3915

Applications and Features

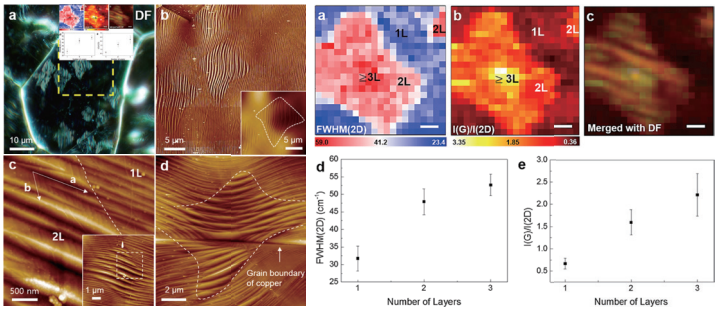
- Fabrication and analysis of the physical properties (components, structures, forms, and electrical/chemical properties) of metal/ceramic/semiconductor nanomaterials is performed without air exposure
- Recipe-based automated process equipment and real-time analysis system
- Electrical/chemical characteristics analysis in operando
- Surface and interface analysis
- Qualitative/quantitative/electronic structure analysis for organic/inorganic and semiconductor thin films
- Sample surface analysis and depth profile analysis of multilayer thin film samples

Representative Research Achievement

➤ Identify the causes of the nano-wrinkles that occur during graphene synthesis

Analysis of the number of layers of graphene and the strain of the graphene grid using a microscope and a Raman spectrometer revealed the cause of nano-wrinkles and provided new concepts for graphene electrode development.

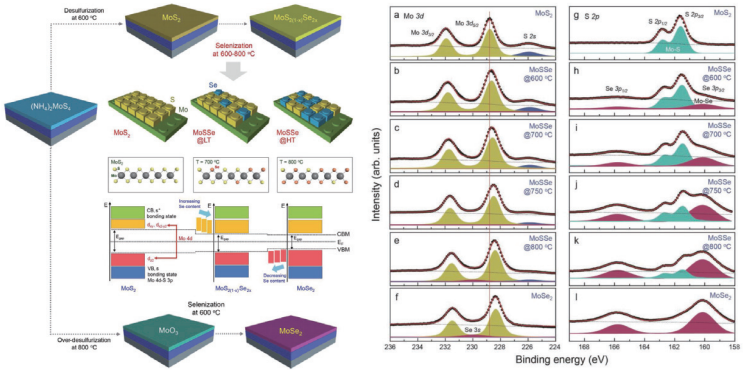
Nano Letters, Vol.16, 2016



➤ Development of an atomic-level customized synthesis method of a 4-inch transition metal chalcogenide multilayer film alloy

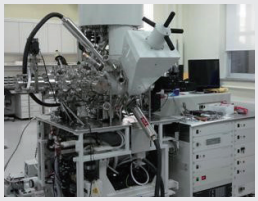
To overcome the disadvantages of MoS_2 and $MoSe_2$ and utilize their advantages, a synthesis method that can adjust the composition of S and Se for Mo in accordance with the required characteristics is developed and applied to the production of nano-optical devices.

Advanced Materials, Vol.31, 2019



Related Instruments

X-ray/extreme-ultraviolet photoelectron spectroscopy



- Model (manufacturer): AXIS Ultra DLD (Kratos Analytical)
- Photon source: non-monochromatic X-ray (Al-Ka and Mg-Ka) and monochromatic Al-Ka (1486.6 eV)
- Energy resolution: ⟨ 0.43 eV for XPS and ⟨ 20 meV for UPS (Ag 3d (5/2))
- Spatial resolution for XPS imaging: ⟨ 3 μm
- Ion cluster gun

Advanced In-situ Surface Analysis System

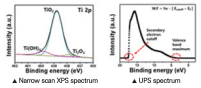
Process equipment

Analysis equipment

Micro X-rayUV Photoelectron Spectroscopy (μ-XPS/UPS)

◆ Equipment overview
- Base pressure: 2 × 10^{-10} Torr
- Photon: Mono Al, Mg, He I & II
- Ar^+ ion cluster source: 5 ~ 20 keV

◆ Purpose of use
- Qualitative and quantitative analyses of material surfaces
- Electronic structure analysis of materials
- Depth analysis using sputtering

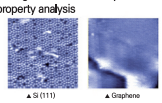


▲ Narrow scan XPS spectrum ▲ UPS spectrum

Scanning Probe Microscopy (SPM)

◆ Equipment overview
- Base pressure: 1 × 10^{-10} Torr
- Temperature range: 90 K ~ 1500 K
- STM, AFM, KPM using KolibriSensor

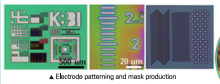
◆ Purpose of use
- Atomic surface analysis
- Bandgap measurement by STS
- 2D organic self-assembly structure and chemical property analysis


▲ Si (111) ▲ Graphene

Pattern Generator

◆ Equipment overview
- Maskless patterning
- Min. feature size of 1 μm
- High power 326 nm UV laser diode

◆ Purpose of use
- Semiconductor device electrode pattern formation
- Chrome mask making
- Microfluidic channel master making

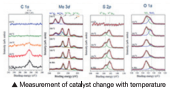


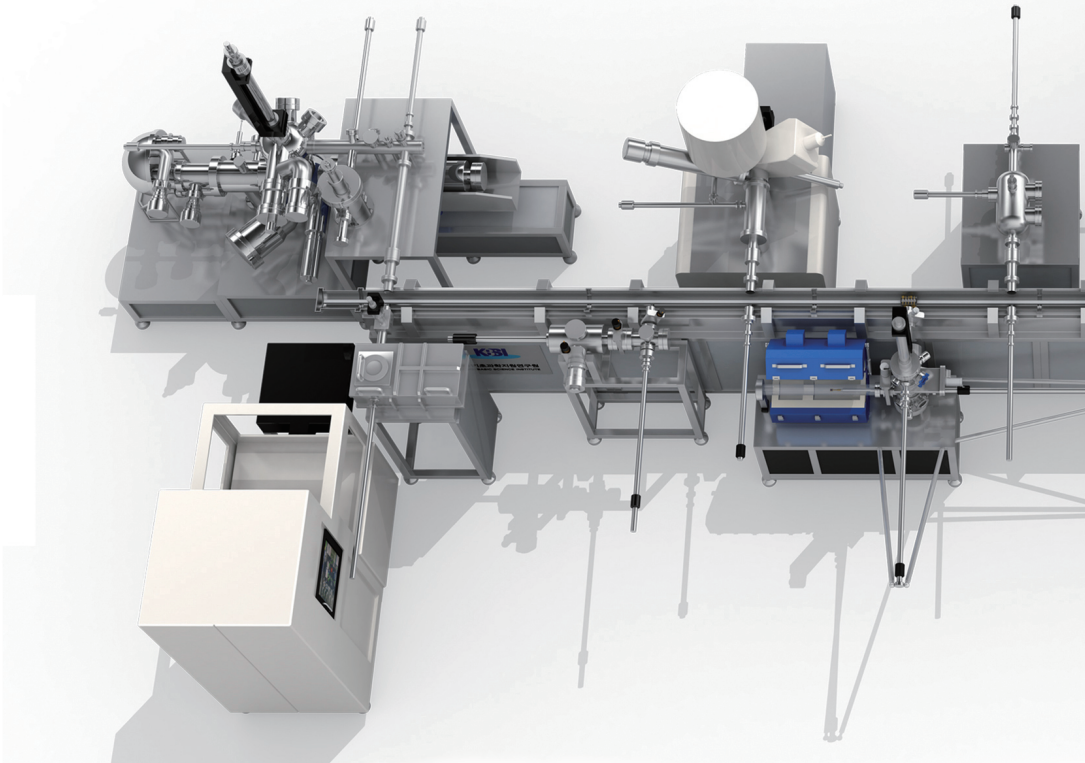
▲ Electrode patterning and mask production

Near Ambient Pressure X-ray Photoelectron Spectroscopy (NAP-XPS)

◆ Equipment overview
- Working pressure: ~3 mbar
- Heating temperature: 873 K
- Available gases: H_2, O_2, H_2O, Ar, etc.

◆ Purpose of use
- Surface analysis during gas-phase catalytic reactions
- Surface analysis during solar cell operation
- Surface analysis during a photocatalytic reaction process


▲ Measurement of catalyst change with temperature



Linear Transfer System (LTS)

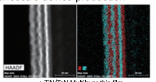
◆ Equipment overview
- Base pressure : 3 × 10^{-10} Torr
- 5 sample storage spaces
- Total extension length of 11.3 m

◆ Purpose of use
- Synthesis of contamination-free samples
- Transport path for surface analysis and device measurement
- Store samples without contamination

Plasma Enhanced Atomic Layer Deposition (PEALD)

◆ Equipment overview
- Plasma power: 50 ~ 350 W
- Gas system: bubbler, vaporizer, LDS
- Process temperature: up to 823 K

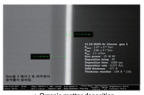
◆ Purpose of use
- Deposition method specialized in thin-film thickness control
- Conformal thin-film growth
- Nanoscale device production


▲ TiN/TaN Multilayer thin film

Thermal Evaporator

◆ Equipment overview
- Vacuum pressure: 〈 10^{-6} Torr
- 3 ports of organic source
- 1 thickness monitor

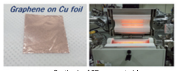
◆ Purpose of use
- Organic matter deposition


▲ Organic matter deposition

Thermal Chemical Vapor Deposition (TCVD)

◆ Equipment overview
- 2 zone heating system
- Heating temperature : ~ 1500 K
- Available gases: H_2, CH_4, N_2

◆ Purpose of use
- Synthesis of 2D nanomaterials
- High-temperature heat treatment
- Metal oxidation treatment

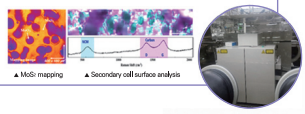


▲ Synthesis of 2D nanomaterials

In-situ Raman Spectroscopy

◆ Equipment overview
- Spatial resolution of 350 nm
- Ultra-high speed (400 times faster)
- Sample transfer without exposure to air

◆ Purpose of use
- Structural change study of 2D materials
- Large-area RAMAN imaging
- Surface analysis of secondary batteries


▲ MoS_2 mapping ▲ Secondary cell surface analysis

Glove Box System

◆ Equipment overview
- Inert gas (Ar) environment
- 〈 0.1 ppm of O_2 and H_2O atmosphere
- O_2, H_2O, solvent sensors included

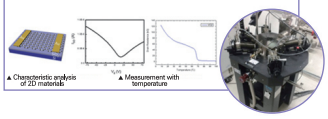
◆ Purpose of use
- Sample preparation and vacuum transfer without air exposure
- Provide metal-organic thin-film deposition environment
- Spin coating and electrode patterning environment

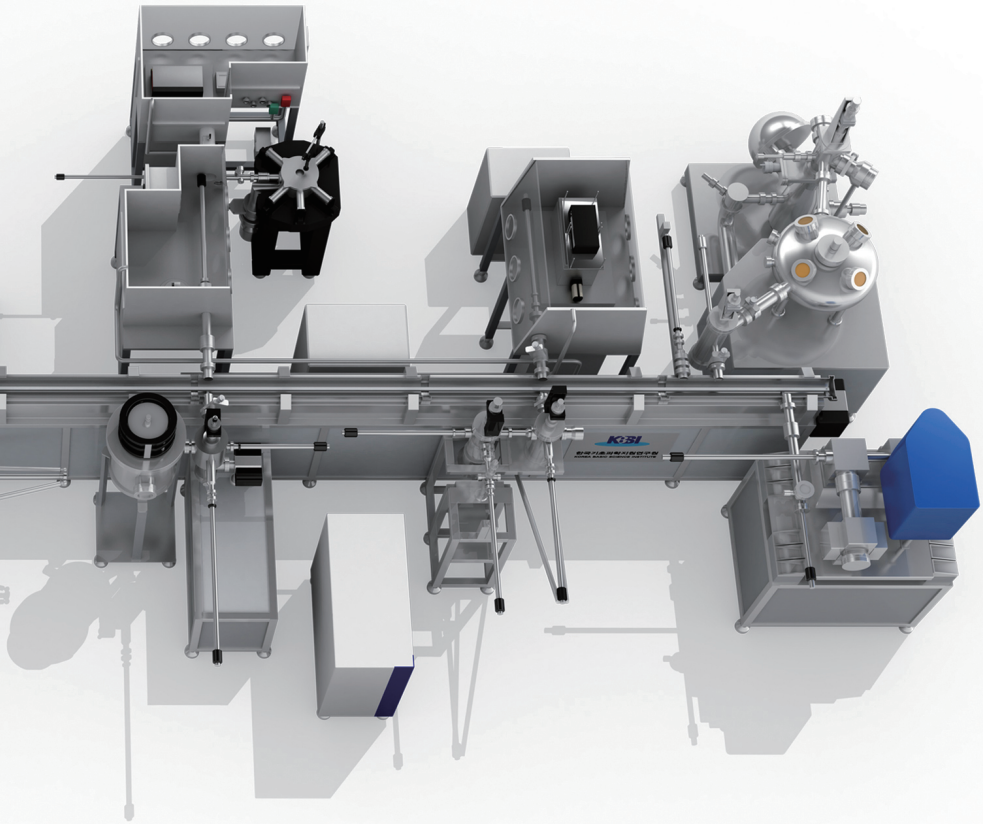

▲ Sample preparation and sample transfer

Low Temp. Probe Station

◆ Equipment overview
- Vacuum pressure: 〈 10^{-7} Torr
- Temperature range: 10 ~ 900 K
- Sample transfer without exposure to air

◆ Purpose of use
- Analysis of electrical characteristics of semiconductor devices
- Analysis of electrical properties of thin energy materials

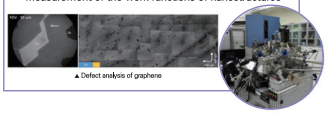

▲ Characteristic analysis of 2D materials ▲ Measurement with temperature



Low Energy/Photoemission Electron Microscopy (LEEM/PEEM)

◆ Equipment overview
- 1.5 & 20 nm resolution for LEEM & PEEM
- μ-LEEM, μ-ARUPS
- Temp. range: 100 ~ 1400 K

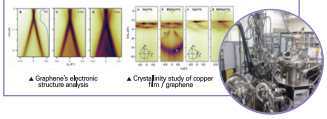
◆ Purpose of use
- Analysis of the layer number and growth mechanism of 2D materials
- Non-destructive analysis of nanomaterial structures and shapes
- Measurement of the work functions of nanostructures


▲ Defect analysis of graphene

Angle-Resolved Photoelectron Spectroscopy (ARPES)

◆ Equipment overview
- VG Scienta DA30 analyzer
- Monochromatic VUV source
- 6 axis manipulator
- Temperature range: 4 ~ 1000 K

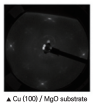
◆ Purpose of use
- Measurement of the band structures of 2D materials
- 2D mapping of crystalline electronic structures


▲ Graphene's electronic structure analysis ▲ Crystallinity study of copper film / graphene

DC-RF Magnetron Sputter

◆ Equipment overview
- Base vacuum pressure: 5 × 10^{-9} Torr
- Working pressure: 〈 10^{-2} Torr
- Substrate temp. range: 298 ~ 1073 K
- Plasma sources : Ar, O_2, N_2 gases

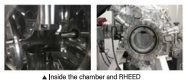
◆ Purpose of use
- Metal and metal oxide thin-film deposition


▲ Cu (100) / MgO substrate

Pulsed Laser Deposition (PLD)

◆ Equipment overview
- Excimer laser : 700 mJ @ 248 nm
- 4 channels 1 inch target
- Substrate heating up to 1273 K

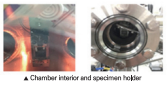
◆ Purpose of use
- Next-generation nano-material thin-film deposition
- Crystallization of epitaxial metal and ceramic materials
- Change in the coating and physical properties of nanoparticles


▲ Inside the chamber and RHEED

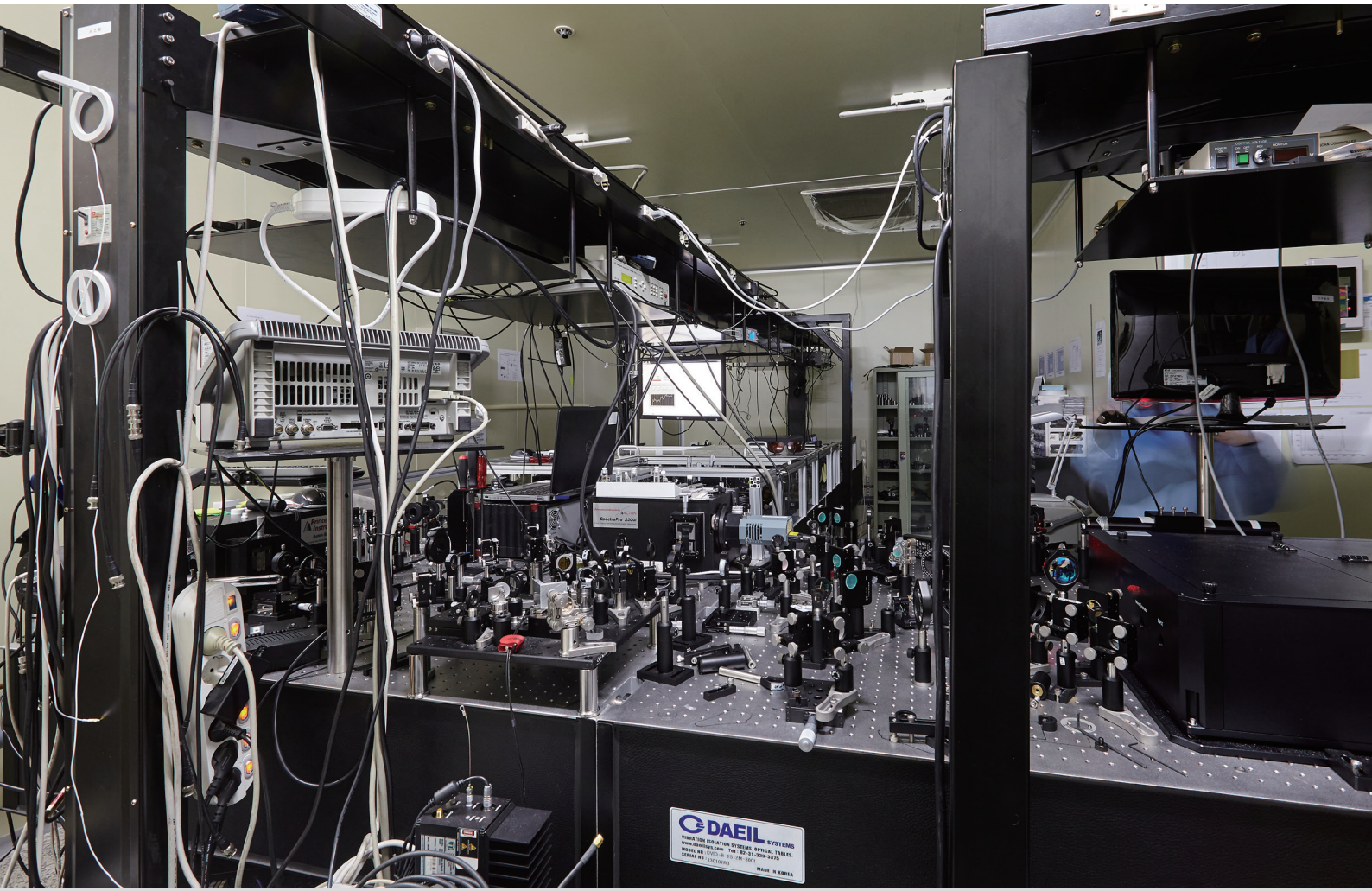
High Vacuum Chemical Vapor Deposition (HV-CVD)

◆ Equipment overview
- Base pressure: 5 × 10^{-10} Torr
- E-beam & DC heating: up to 1473 K
- Gas pressure controlled by precision leak valve

◆ Purpose of use
- Chamber maintaining ultra-high vacuum
- Pollution-free surface reactors can be created
- Gas or liquid-type sources can be used


▲ Chamber interior and specimen holder

Femtosecond Multi-dimensional Laser Spectroscopic System



Model_ Coherent Libra

- Regenerative amplifier: 1 ㎑, 3.5 mJ/pulse, ~ 50 fs
- Optical parametric amplifier: tunable wavelength 240 ~ 2,600 ㎚, and pulse duration 〈100 fs
- Spectral resolution: 0.2 ㎚ (at 530 ㎚)
- Time scan range: typically 0 – 1 ns for transient absorption (TA) measurement

| Natural Science Campus, Korea University, 145 Anam-ro, Seongbuk-gu, Seoul 02841, Republic of Korea
| Instrument code: ST012 | Dr. Hanju Rhee, Dr. Sanghee Nah, Dr. Jeong-Hyon Ha (Seoul Center)
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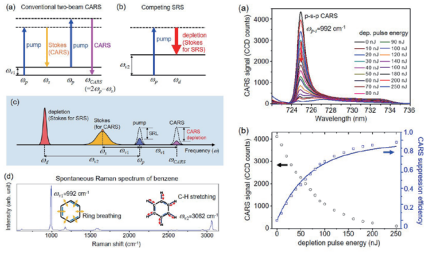
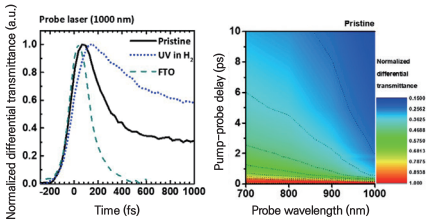
Applications and Features

- Real-time analysis of chemical exchange processes using 2D IR spectroscopy
- IR-visible 2D vibrational and electronic spectroscopy (nanoparticles, photosynthetic systems, etc.)
- Pump-probe TA analysis of various molecular systems and materials (metallic or semiconducting nanoparticles)
- Coherent Raman scattering spectroscopy and imaging based on stimulated Raman scattering (SRS) and coherent anti-Stokes Raman scattering (CARS) processes
- Development of femtosecond chiroptical spectroscopy and imaging techniques



Development of non-linear Raman spectroscopic techniques for label-free super-resolution vibrational imaging

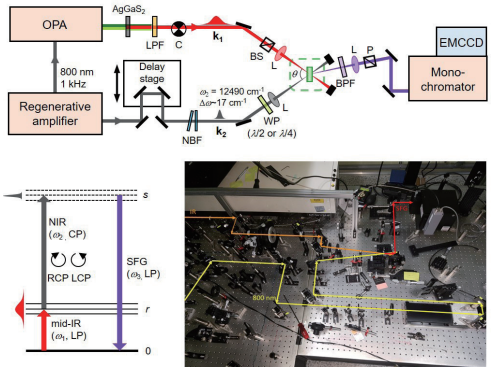


Femtosecond time-resolved spectroscopy of a nanomaterial sensor

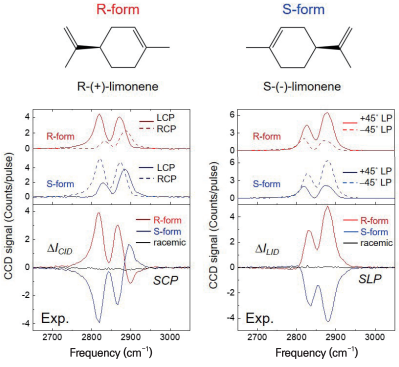
Representative Research Achievement

➤ Development of a new chiral sum-frequency generation (SFG) spectroscopic technique distinguishing mirror-imaged enantiomers

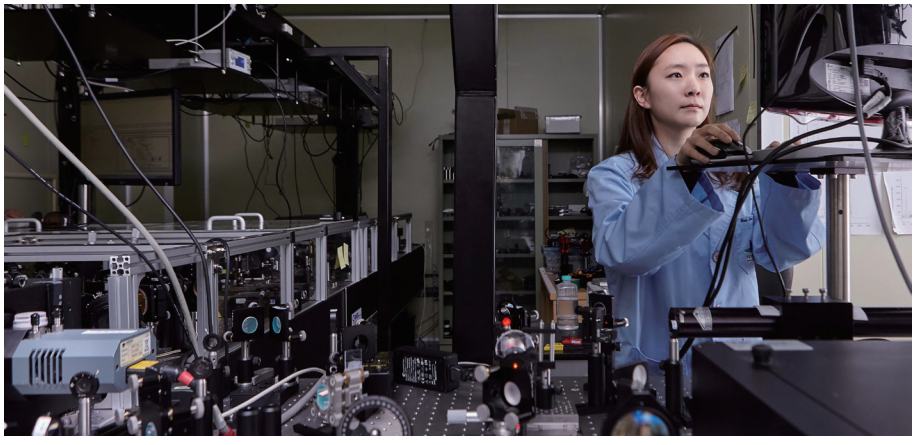
Development of a new chiral SFG spectroscopic technique using femtosecond IR and visible laser pulses to distinguish two different stereochemical structures (R-form vs. S-form) of mirror-imaged enantiomers.



Femtosecond chiral SFG spectrometer at the KBSI



Representative chiral vibrational SFG spectra of R- and S-limonenes and their racemic mixture



Leading the Innovation of
Advanced Science
World-class Research Infrastructure

KBSI
Leading-edge Equipment

KBSI KOREA BASIC SCIENCE INSTITUTE

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