# 사람 코보다 정확한 바이오나노 전자코 기술 개발


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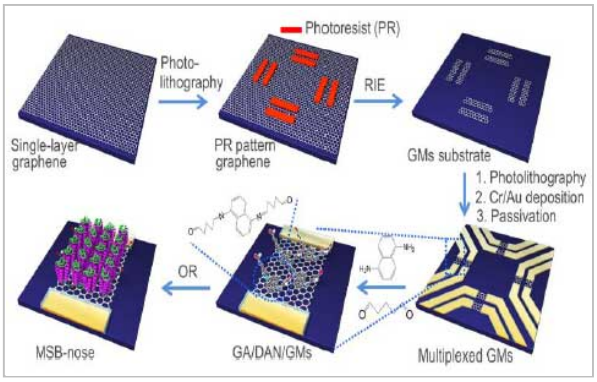
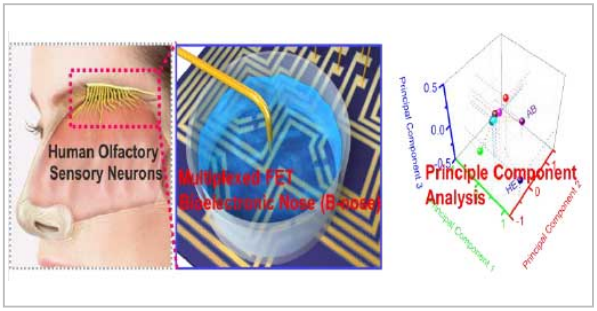
## 연구내용

제조된 그래핀 마이크로 패턴 트랜지스터와 다종의 인간 후각 수용체를 결합하는 방식으로, 특정 냄새분자와 선택적으로 결합하는 후각 수용체들을 부착하여 여러가지 냄새를 한번에 인지할 수 있는 인공후각 재현 기술 개발에 성공하였음.

특히, 세포막에 발현되는 막 단백질로 이루어져 그 구조가 매우 복잡하고 이종세포에서의 발현이 극히 어려운 것으로 알려져 있는 후각 수용체를 대장균 시스템에서 대량으로 발현 후 분리 정제하는데 성공하여 전자코의 효용성을 더욱 높였음.




[그림 1] 그래핀 마이크로 패턴 기반 고 감응성 다중 냄새분자 바이오나노 전자코 제조 모식도




[그림 2] 복잡한 인간후각시스템을 그래핀 마이크로 패턴 전계효과 트랜지스 기술로 재현하였으며, 주성분 분석(principle compoinen analysis PCA)법을 통하여 다중 검출 데이터를 분석하였음

## 기대효과

이번 연구성과는 사람의 코를 대체할 기술로, 유독가스와 같은 인체에 해를 끼치는 냄새 물질의 감지, 질병들 특히 암의 지표 물질을 사람의 호흡이나 소변에 포함된 특정 휘발성 유기화합물 인지, 식품 및 향수 감별, 마약 및 생화학무기 조기 검출 등 다양하게 활용될 수 있으며 인간 후각의 코드화를 통한 향기나는 TV등 미래기술에 적용 가능함.

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**An Ultrasensitive, Selective, Multiplexed Superbioelectronic Nose That Mimics the Human Sense of Smell**

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Supporting Information


**ABSTRACT:** Human sensory-mimicking systems, such as electronic brains, tongues, skin, and ears, have been promoted for use in improving social welfare. However, no significant achievements have been made in mimicking the human nose due to the complexity of olfactory sensory neurons. Combinational coding of human olfactory receptors (hORs) is essential for odorant discrimination in mixtures, and the development of hOR-combined multiplexed systems has progressed slowly. Here, we report the first demonstration of an artificial multiplexed superbioelectronic 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 component analysis.



**KEYWORDS:** *Multiplexed bioelectronic nose, graphene micropatterns, field-effect transistor, olfactory receptor, human mimicking, odorant discrimination*


Humans can identify odors based on a combination of multiple olfactory signals in olfactory bulbs; these signals are collected through multiple olfactory sensory neurons (OSNs) that express different olfactory receptors.[1,2] In particular, the human nose expresses a large family of olfactory receptors (approximately 390 different olfactory receptors) and can recognize and distinguish specific odorants by recognizing end-functional groups at a resolution equivalent to a single carbon atom.[1,3] The exceptional receptor/odorant interactions that occur in the human olfactory system enables high selectivity and sensitivity to target odorants, even at low concentrations.[3,6] In previous work, efforts at mimicking the human nose have inspired odorant-sensing systems that involve components such as field-effect transistors (FETs) and chemoresistors, resulting in single-channel bioelectronic-noses (B-nose).[7−11] However, single-channel human-mimicking electronics, such as electronic-tongue,[12−14] -skin,[15] and -ear[16] devices, are unable to encode human olfactory receptor (hOR) combinations representing distinct odor identities because these systems are unable to simultaneously discriminate more than two odorants. Furthermore, the reported transducers were irregularly deposited or immobilized onto the FET substrates, resulting in poor reproducibility.

Recently, Food and Drug Administration (FDA)-approved odorants have been included in consumer products such as foods, beverages, and fragrances.[17] Such odorants are characterized by their unique structures and are harmonized exactly with hORs; however, unexpected side-effects can occur in sensing odorant mixtures, off-odors, and antagonists.[18,19] For example, unlike single odorants, the fragrance of a mixture can be sensed as a completely different odor, and the odor intensity of the mixture can lie between the intensities of the unmixed components.[20] Such odor changes in mixtures provide incorrect


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