

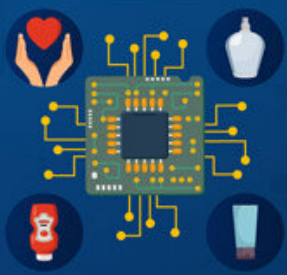
Sensing odor molecules on a graphene surface layered with self-assembled peptides

January 19 2023

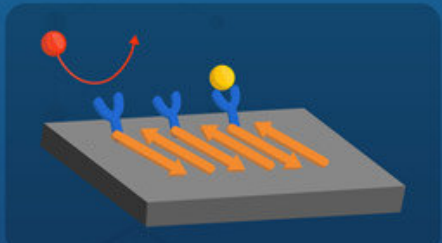
New Graphene Field-Effect Transistors with Peptides for Odor Biosensing

Graphene field-effect transistors (GFETs) with olfactory receptors are gaining momentum in odor sensing applications due to their high sensitivity

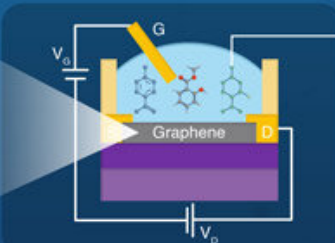
However, their application as commercial biosensors is limited by their fragility and complex structures



Selective detection of odor molecules using peptide-functionalized GFETs



Self-assembled peptide-based bio-probe



GFET setup

✓ Sensing through change in graphene conductivity

✓ Distinct signatures for each odor molecule with each peptide

✓ Characteristic adsorption and desorption time constants

These novel peptide-functionalized GFETs pave the way toward customizable, mass-produced probes for the multi-dimensional analysis of odor molecules

Designable peptides on graphene field-effect transistors for selective detection of odor molecules

Homma et al. (2023) | *Biosensors and Bioelectronics* | 10.1016/j.bios.2022.115047



Credit: *Biosensors and Bioelectronics* (2022). DOI: 10.1016/j.bios.2022.115047

Graphene-based olfactory sensors that can detect odor molecules based on the design of peptide sequences were recently demonstrated by researchers at Tokyo Tech. The findings indicated that graphene field-effect transistors (GFETs) functionalized with designable peptides can be used to develop electronic devices that mimic olfactory receptors and emulate the sense of smell by selectively detecting odor molecules.

Olfactory sensing or odor sensing is an integral part of many industries including health care, food, cosmetics, and environmental monitoring. At present, the most commonly used technique for detecting and estimating odor molecules is [gas chromatography–mass spectrometry](#) (GC–MS). Though very effective, GC–MS has some limitations, such as its bulky setup and limited sensitivity. As a consequence, scientists have been looking for more sensitive and easy-to-use alternatives.

In recent years, graphene field-effect transistors (GFETs) have begun being used to develop highly sensitive and selective odor sensors by integrating with [olfactory receptors](#), also known as electronic noses. The atomically flat surfaces and high electron mobility of graphene surfaces make GFETs ideal for adsorbing odor molecules. However, the application of GFET as electrical biosensors with the receptors is severely limited by factors, such as the fragility of receptors and the lack of alternative synthetic molecules that can function as olfactory receptors.

A team of researchers from Tokyo Institute of Technology (Tokyo Tech) led by Prof. Yuhei Hayamizu set out to address these issues with GFET-based olfactory receptors. In their recent study published in *Biosensors and Bioelectronics*, the team designed and developed three

new peptides for graphene biosensors that can detect odor molecules.

Prof. Hayamizu explains "The sequence of peptides we designed needed to perform two main functions—acting as a biomolecular scaffold for [self-assembly](#) on a graphene surface and functioning as a bio-probe to bind the odor molecules. This would allow the peptides to cover the graphene surface in a self-assembling manner and functionalize the surface uniformly to capture odor molecules."

The team carried out [atomic force microscopy](#) which showed that the peptides uniformly covered the graphene surface with the thickness of a single molecule. The functionalized graphene was then used to build a GFET setup for detecting odor molecules. After the assembly, the team injected limonene, menthol, and methyl salicylate as representative odor molecules into the GFET. The electrochemical measurements indicated that binding with the odor molecules reduced the conductivity of the [graphene](#). The observations also revealed that the interaction between the three peptide sequences and the odor molecule gave rise to very distinct signatures. This confirmed that the GFET's response to the odor molecules depended on the peptide design.

Furthermore, the team carried out real-time electrical measurements to monitor the kinetic response of the GFET. The observations indicated that the time constraint associated with the adsorption and desorption of odor molecules was unique for each of the peptide sequences. This behavior was further confirmed by principal component analysis. These observations confirmed that the new GFET setup was successful in electrically detecting the odor molecules with the help of the designed peptides.

"Our approach is simple and can be scaled up for mass production of peptide-based olfactory receptors that can mimic and miniaturize the natural protein receptors responsible for our sense of smell. We are a

step closer to realizing the concept of electronic noses," says Prof. Hayamizu.

The robust approach presented in this study opens new doors for the development of highly selective and sensitive GFET-based odor-sensing systems. These insights can also be put to use when designing advanced peptide sensors that can carry out multi-dimensional analysis of a range of [odor molecules](#).

More information: Chishu Homma et al, Designable peptides on graphene field-effect transistors for selective detection of odor molecules, *Biosensors and Bioelectronics* (2022). [DOI: 10.1016/j.bios.2022.115047](#)

Provided by Tokyo Institute of Technology

Citation: Sensing odor molecules on a graphene surface layered with self-assembled peptides (2023, January 19) retrieved 24 June 2024 from <https://phys.org/news/2023-01-odor-molecules-graphene-surface-layered.html>

<p>This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.</p>
--