

Pencil, paper & graphene brought together for sensors useful for hospital and farms

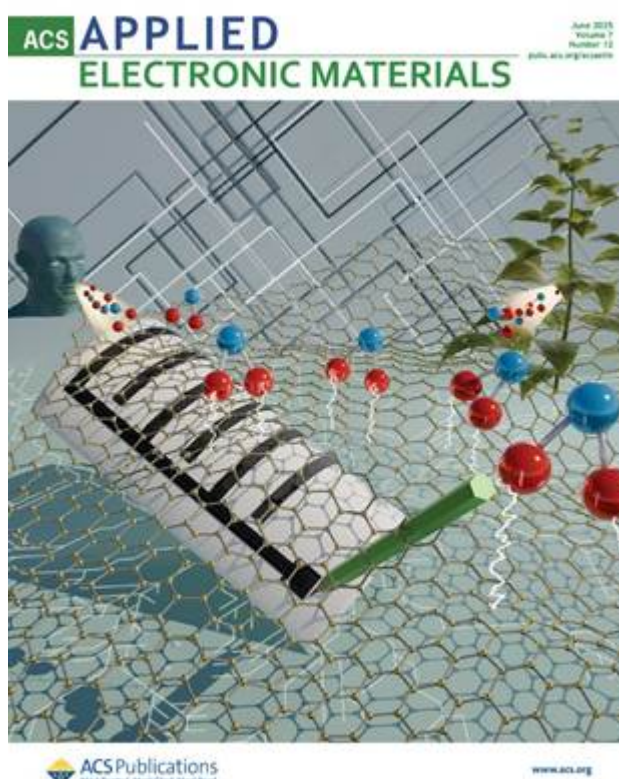
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A flexible, low-cost multipurpose pencil on paper sensor developed could carry out activities ranging from measuring soil moisture, detecting plant drought stress, tracking human breathing patterns, to acting as smart diaper wetness detector.

Sensors are a part of everyday life today. They are present in phones and smartwatches and required in hospitals and farms. But most conventional sensors are built on rigid materials, use costly metals like gold or platinum, and require complex manufacturing processes. This makes them expensive, unscalable, and hence unsuitable for large-area applications such as agriculture or wearable health monitoring.

Research, carried out by Dr. Hemen Kumar Kalita and his PhD students, Rajnandan Lahkar and Biswajit Dehingia, at the Department of Physics, Gauhati University, addresses the critical need for low-cost, flexible, and sustainable sensor technologies for applications in agriculture and healthcare.

The researchers developed a flexible graphene-based capacitive sensor fabricated on a paper substrate using pencil-drawn interdigitated electrodes (IDEs). Ordinary pencils are used to draw conductive graphite electrodes directly onto paper, while graphene oxide (GO) serves as the active sensing material. This approach eliminates the need for costly metals, cleanroom facilities, and chemical-intensive fabrication steps. The resulting sensor is lightweight, mechanically flexible, environmentally friendly, and extremely cost-effective, making it well-suited for disposable and large-area sensing applications.



The work published in the international peer-reviewed journal ACS Applied Electronic Materials, demonstrates significant advancement over existing paper-based and flexible sensor technologies. While earlier sensors often suffer from low sensitivity, high fabrication cost, or single-function operation, the developed sensor exhibits exceptionally high sensitivity to humidity and moisture, with a response exceeding 1500% at high relative humidity.

The same sensor has been successfully demonstrated for multiple real-world applications, including soil moisture sensing, plant drought stress monitoring through transpiration analysis, human breath monitoring, skin moisture tracking, non-contact proximity sensing, and smart diaper wetness detection. The ability to integrate such diverse functionalities into a single, low-cost device highlights the novelty and technological significance of this work.

By integrating paper substrates, pencil-drawn electrodes, and GO, the research demonstrates that high-performance sensors can be developed using simple, low-cost, and locally adaptable approaches.

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