Revolutionizing Health and Environmental Monitoring with 2D Material-Based Chemical Sensors.

Rayhane Zribi ^{1,2*}, Ratiba Wali ³, Antonino Foti ², Pietro G. Gucciardi ², Giovanni Neri ¹. ¹ Department of Engineering, University of Messina, C.da Di Dio, I-98166, Messina, Italy. ² CNR IPCF Istituto per i Processi Chimico-Fisici, viale F. Stagno D'Alcontres 37, I-98156 Messina, Italy. ³ Laboratory of Ceramic Composite Materials and Polymers, Sciences Faculty of Sfax, Route soukra km 3, 3000 Sfax, Tunisia. razribi@unime.it

The rise of 2D materials has revolutionized sensor technology, offering cutting-edge solutions for both medical and environmental applications. These ultra-thin, highly sensitive sensors are transforming the way we monitor health and the environment, enabling real-time, precise measurements with minimal energy consumption. Their exceptional properties make them ideal for next-generation sensing technologies. In the medical field, 2D material-based sensors provide ground breaking advancements in non-invasive diagnostics, health monitoring, and personalized treatment, significantly enhancing patient outcomes. They enable early disease detection, continuous monitoring, and tracking of biomarkers in bodily fluids such as sweat, saliva, and blood [1]. This reduces the need for invasive procedures and provides more accessible healthcare solutions. Additionally, these sensors can be integrated into smart and sometimes wearable devices, allowing patients and healthcare providers to monitor vital signs, glucose levels, or even neurological activity with unprecedented accuracy. Beyond healthcare, 2D material-based sensors play a crucial role in environmental monitoring and food safety. Their high surface-area-to-volume ratio and unique electronic properties allow for the precise detection of pollutants, water contaminants, and pesticides at different concentrations (Figure 1). These sensors can detect the presence of pesticide in food [2], detect toxic gases in industrial settings, and monitor heavy metal contamination in water supplies. As climate change and pollution threats grow, such technologies are instrumental in ensuring sustainability and public safety. This presentation will explore the innovations behind 2D material sensors and examine how altering their size and thickness impacts their sensitivity. Understanding these factors is essential for optimizing sensor performance, broadening their applications, and unlocking new possibilities across scientific, industrial, and commercial domains.

References

[1] R. Wali, et al. Materials Advances. Submitted.

[2] R. Zribi, et al. ACS Appl. Mater. Interfaces, 17, (2025), 247-259.

Figures





Graphene2025