

Assembly of novel 2-dimensional composite material architectures for energy storage and environmental applications

Vincenzo Palermo,^{a,b}

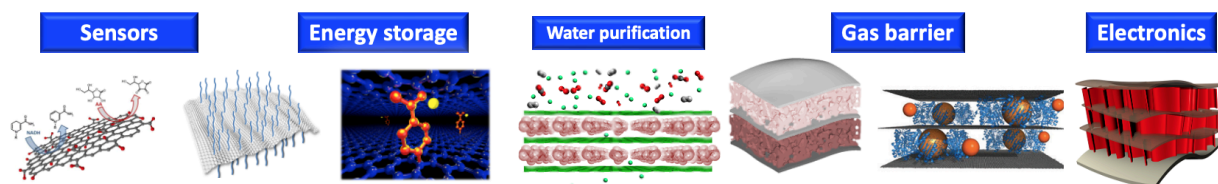
^a ISOF, National Research Council of Italy, Bologna.

^b Chalmers University of Technology, Göteborg, Sweden.

2D nanosheets like graphene or its derivatives can be processed, functionalised and then re-assembled together to create new layered composites with useful applications. One of the peculiar properties of 2-dimensional materials (2DM) is their high aspect ratio, with a thickness of few angstroms and a lateral size that can span hundreds of microns. When two nanosheets are stacked together, the space between them forms a 2D-confined environment which can capture, transport or store small molecules and ions. Here, we will give an overview of novel layered composites with original structure that we produced recently, with useful applications in the sectors of energy storage using lithium and sodium, in sensing and in water/gas purification. Some example of possible applications are:

- Graphene-organic composites for sodium-ion batteries.¹
- Graphene-polymer composites for selective ion and gas sieving.^{2,3}
- Graphene oxide electrodes for brain cell electrical stimulation.⁴
- 2D-3D nanocomposites for AI-powered chemical sensors.⁵⁻⁷

The materials we describe, besides showing in all cases good performance versus state-of-the-art, demonstrate also the high maturity and versatility reached by the processing of 2D materials into bulk applications, beyond the random mixtures typically used in composites.



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- 4 Fabbri, R. *et al.* Graphene oxide electrodes enable electrical stimulation of distinct calcium signalling in brain astrocytes. *NATURE NANOTECHNOLOGY* (2024). <https://doi.org/10.1038/s41565-024-01711-4>
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BIOSKETCH

Vincenzo Palermo is the director of the CNR Institute for Organic Synthesis and Photoreactivity (ISOF) in Bologna, Italy, and associated professor of Chalmers University of Technology (Sweden). He uses nanotechnology and supramolecular chemistry to create new materials for electronics, aerospace and biomedical applications. He published >200 scientific articles on international journals in chemistry, nanotechnology and materials science (>12 000 citations, h-index 55), collaborating with key industrial partners in Europe (Airbus, FCA, Leonardo, BASF, Nokia, STMicroelectronics etc.). He coordinated several EU projects in the past, including being vice-director and member of the executive board of the Graphene Flagship, one of the largest research projects ever launched in Europe. He has been awarded the Lecturer Award for Excellence of the Federation of European Materials Societies (FEMS), the Research Award of the Italian Society of Chemistry (SCI) and the Science dissemination awards of the Italian Book Association. He writes as a columnist for the science magazine SAPERE and has published two books on the life and science of Albert Einstein (Hoepli, Milano, 2015) and of Isaac Newton (Hoepli, Milano, 2016).

