The Universe of Disordered and Amorphous Two-dimensional Materials: Scientific Challenges & Technology Opportunities

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Abstract

After fifteen years of pursuing the fabrication or single crystal growth of monolayer materials, it turns out that for plenty of practical and performances reasons, more disordered forms such as reduced graphene oxides, polycrystalline or even totally amorphous forms of monolayer membranes present superior properties for heterostructures applications and composites. Here I will discuss the importance to explore the variety of physical properties of such disordered or completely amorphous forms of two-dimensional based materials and devices in the context of industrial applications including gas sensing, composites for thermal, electronic and spintronic applications. Recent results on gas sensors will be discussed within the context of the ULISSES European project which ambition to advance towards the most performant CO2 gas sensors architecture and integrability into commercial products.

In absence of usual approximations of periodicity and long range order, the supremacy of so-called order N methodologies will be shown, with striking illustrations of quantitative predictions when contrasted with experimental data, in the context of industrial research. For polycrystalline 2D materials, amorphous graphene and reduced oxide graphene, charge and thermal transport studies will be presented, illustrating the high level of quantitative capability of order N methods and their usefulness as guiding tools for materials and device innovation and optimization.

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