Emerging Amorphous Two-Dimensional Materials

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Formidable progress has been recently achieved in the fabrication and characterization of disordered materials with unprecedented properties. In this context, particular forms of disordered graphene (reduced graphene oxides), obtained by chemical exfoliation techniques, have been found suitable to improve the performances of composite materials for energy applications. Moreover, the recent wafer-scale synthesis of *two-dimensional amorphous carbon monolayers*, structurally dominated by sp2 hybridization has ignited a formidable research of alternative forms of membranes with superior coating properties [1,2]. The uniqueness of 2D amorphous materials derive from the inherent imperfect structural nature which, controlled at the fabrication level, represents the key ingredient for specific target applications. In this respect, new fabrication strategies to modify the degree of disorder and a systematic theoretical characterization of the impact of the material structural quality on the ultimate performance is urgent. Even more importantly, the search for new disordered materials for novel applications appears as an extremely promising way.

In this talk I will present the results of our theoretical investigation on possible strategies to improve the (thermal) reduction process of graphene-oxides and the consequent possibility to recover the quality of pristine graphene [3]. Moreover, we present a systematic analysis of the structural and vibrational properties of amorphous carbon monolayers as a function of the structural quality of the material, showing how disorder results in a tunable thermal conductivity varying by more than one order of magnitude [4]. Finally, one will discuss the newly synthesized thin film of amorphous Boron Nitride showing extremely low dielectric characteristics: high breakdown voltage and likely superior metal barrier properties [5]. The fabricated material has great potential as interconnect insulator in the next-generation of electronic circuits. We discuss the experimental setup and present the results of our calculations which have contributed to the understanding of the structural morphology of the amorphous material as well as explaining the superior dielectric performances.

References

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Figures

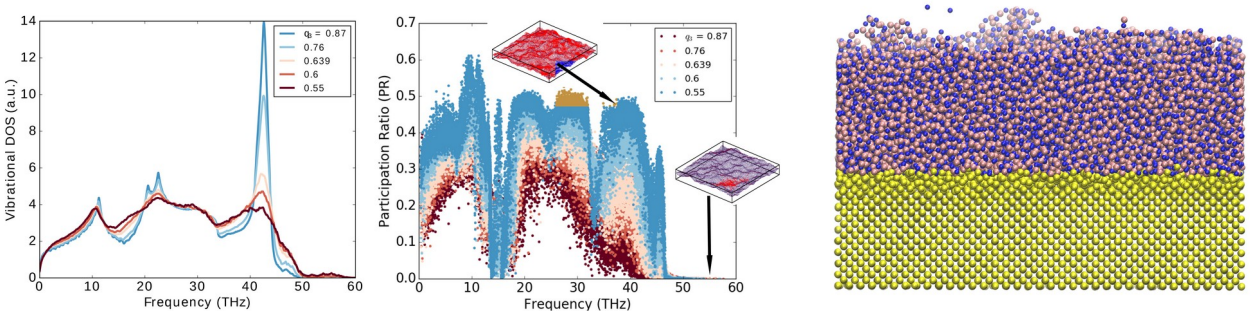

Figure 1. (Left) Vibrational DOS of Amorhous Graphene for different degrees of amorphousness. (Right) Participation Ratio of the samples and atomic displacements (insets) Figure 2. Atomistic sample of Amorphous Boron Nitride