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Beyond graphene: The amazing world of layered transition metal dichalcogenides

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Graphene, an atom thick of carbon semimetal, has attracted a great deal of attention due to its new properties and promising applications which might have impact in new electronic devices, novel composite materials, innovative sensors, etc. However, graphene it is not alone, there is also hexagonal boron nitride (H-BN) a layered insulator which can be combined with graphene to form new hetero layer materials. Moreover, there are flat layered structures made out of transition metal dichalcogenides (TMD) such as MoS₂, WS₂, MoSe₂, WSe₂, NbS₂, NbSe₂, WTe₂, etc., which can behave as semiconductors or metals depending on the atoms involved. Interestingly, one monolayer of a semiconducting TMD exhibits a direct band gap which vanishes when adding another layer, thus producing an indirect band gap bilayer material. Since monolayer semiconducting TMD, with trigonal prismatic structure, do not possess center of inversion, exhibit valley polarization effects which envisage their application in non-linear optics and in a new field called valley-tronics. In this talk, theoretical and experimental efforts to shed light on the comportment of TMDs will be provided. First, the main synthesis methods of monolayer TMDs such as exfoliation, chemical vapor transport and chemical vapor deposition will be studied along with their main challenges. Second, the role of defects and doping of TMDs will be analyzed, and finally, first principles calculations to understand their opto-electronic behavior and Raman scattering will be also explained.

Biography

Humberto Terrones carried out his PhD at the University of London under the supervision of Prof. Alan L Mackay. Later, these ideas were implemented to understand defects in 2-D graphitic systems and were extended to transition metal dichalcogenides. He has been invited Professor in Belgium (UCL), Brazil (UFC), Japan (Shinshu), USA (ORNL, Penn State) and UK (Sussex). He is Rayleigh Endowed Chair professor of physics at Rensselaer Polytechnic Institute.

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