SEMINAIRE ISMO

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2D materials beyond graphene : synthesis, properties and applications from the single layer toward the heterostructure

In December 1959, Richard P. Feynman in his famous lecture entitled «*There's Planty of Room at the Bottom*», introduced the importance of layered materials and specifically proposed the isolation of individual layers. He stated *"What could we do with layered structures with just the right layer? What would the properties of materials be if we could really arrange the atoms the way we want them…"*. We had to wait until 2004 to see this prediction attempted, when Novoselov et al. discovered the truly novel transport properties of individual graphene sheets through mechanical exfoliation of graphite. The isolation of graphene was a defying moment for the "birth" of a field: ***two-dimensional (2D) materials***. In fact a year later, the same group demonstrated that, by using repeated mechanical exfoliation, one could isolate monolayer of other layered materials. Interestingly, more than half a century after Feynman's lecture, we now know that, by controlling the number of layers of these materials, engineering unprecedented physicochemical properties is possible. In addition to the isolation of individual layers, one can also stack layers of different materials on top of each other in desired orientations and thereby engineer novel heterostructure with unprecedented properties. In this talk, I will focus the attention on the 2D family of transition metal dichalcogenides MX_2 (e.g., MoS_2) and monochalcogenides MX (e.g., GaSe). These materials have gained world-wide attention in recent years and are being heavily researched for use in photovoltaic devices, lithium ion batteries, hydrogen evolution catalysis, transistors, photodetectors, DNA detection, and memory devices. In particular, by means of x-ray photoemission spectroscopy (XPS) and angle resolved photoemission spectroscopy (ARPES), I will discuss the electronic properties of these 2D materials and how these properties can be modulated (number of layers, role of defects, interlayer interaction, stacking orientation). I will present the cases of different type of van der Waals heterostructures, going from the 2D/2D systems until the more peculiar case of mixed dimensional vdW heterostructure (2D/3D materials).

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