Unveiling the Power of 2D Semiconductors: Revolutionizing Sub-5 nm Transistor Technology

Arely Cano[1], Arturo Escobosa[1], Magali Estrada[1], Iouri Koudriavtsev[1], Victor Sanchez[1], Zuhawn Sung[2], Arturo Morales[1]

[1] Center for Research and Advanced Studies of the National Polytechnic Institute, [2] Fermi National Accelerator Laboratory

The exfoliation of graphene in 2004 generated renewed interest in 2D materials of atomic thickness, given the unique properties of this type of materials. Since then, many analogues have been obtained and are studied, including silicene, germanene, stanene, black phosphorus, hexagonal boron nitride, among others. We know, from what is currently published, and from the experience of the proponent, that we can obtain many 2D materials with band gap values in the UV-Vis-NIR spectral region, unlike graphene and its analogues (silicene, germanene, stanene) that behave like semimetals.

This contribution is oriented in this context and its objectives are to obtain and study new 2D semiconductor materials of nanometer thickness and take advantage of their unique properties for applications in optoelectronics and photonics. Most of the 2D semiconductors we refer to in this contribution can be obtained and exfoliated by mild chemical routes, and/or prepared through CVD. Regarding its structural, morphological, surface characterization, optical properties, calculation of the band structure, etc., access to the experimental and calculation infrastructure is not a limitation to execute the project. That experimental infrastructure is within our reach. The science and technology of 2D semiconductors is in the early years, and its study is an urgent need to advance in the construction of chips below 4 nm. Silicon-based technology faces serious limitations below that scale. It is in that region, the chips of 4 nm and those of smaller size, where 2D semiconductors will have a great role, without ignoring optoelectronics and quantum computing.