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Atomic resolution transmission electron microscopy study of 2D ultrawide bandgap semiconductor materials intercalated between SiC and epitaxial graphene

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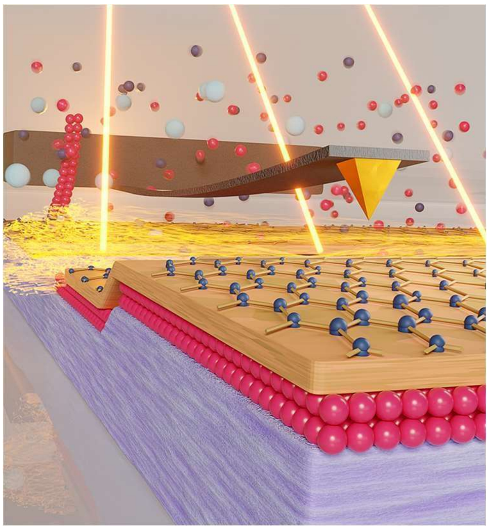
The global environmental emergency requires the transition to renewable forms of energy and the adoption of efficient methods for the distribution, conversion and use of electricity. In this context, the extraordinary advances achieved over the last few years in the technology of wide-band gap semiconductor materials, such as silicon carbide (SiC) and gallium nitride (GaN), have been at the basis of the transition to high-performance electronics, high performance, and high energy efficiency able to respond to the emergency posed by global warming.
The recent demonstration of new two-dimensional forms of GaN and other nitrides [1](InN and AlN) opens up new perspectives for the application of these materials in micro and nanoelectronics.
Although the 2D forms of nitrides are not stable under ordinary conditions, we have shown that it is possible to obtain ultra-thin and very extensive layers by exploiting the intercalation of aluminum or indium and nitrogen atoms between graphene and SiC. [2][3]
Direct evidence of successful intercalation of different 2D layers has been studied thanks to the use of advanced techniques of transmission electronic microscopy, able to make us to know in depth the structural and chemical characteristics of these systems at the level of the individual atomic layers.
The demonstration of these new 2D forms of nitrides, will allow the creation of new ultra-fast and energy-efficient transistors, capable of operating at frequencies from 100 GHz to THz, or capable of opening new frontiers in telecommunications beyond 5G technology, in medical diagnostics and safety. Our laboratory is equipped with a latest generation electron microscope with incredible resolving capabilities, with
which it was possible to understand in detail the positions and chemical bonds of the atoms in the layers of intercalated nitrides. These experiments were supported by the ESTEEM3 project which makes it possible to access the most powerful electron microscopy characterization techniques in Europe, of which BeyondNano is a member of.



Figures 1 model of a two-dimensional semiconductor-based device intercalated through Graphene

[1] *Z.Y. Al Balushi et al. Nature Materials 15(11) (2016) 1166-1171*
[2] *B. Pécz et al. Adv. Mater. 33 (2021) 2006660*
[3] *A. Kakanakova-Georgieva Applied Surface Science 548 (2021) 149275*

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