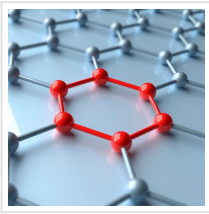
Blue-light Emitting Heterojunctions Based on Graphene Could Open the Way to New Optoelectronic Devices



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Researchers from the Ulsan National Institute of Science and Technology (UNIST) in collaboration with ICREA, demonstrated that heterojunctions between graphene and boron nitride, in in-plane heterostructures, emit blue photoluminescence, which could be potentially used for optoelectronics devices.

Two-dimensional (2D) heterostructures, in which different materials occupy distinct areas of a same crystal, are largely studied in order to understand quantum phenomena emerging in them. Particularly interesting are the boundaries between the materials, which take the name of heterojunctions and are relevant to applications in electronics and optics.

In a paper recently published in Nature Communications, researchers from the Ulsan National Institute of Science and Technology (UNIST, Republic of Korea) and other institutions in Korea, México, Japan and Spain (ICN2) showed that heterojunctions connecting graphene and hexagonal boron nitride, in 2D in-plane heterostructures, emit blue photoluminescence. ICREA Prof. Stephan Roche, leader of the ICN2 Theoretical and Computational Nanoscience Group, and Prof. José Eduardo Barrios-Vargas, from the National Autonomous University of Mexico (UNAM), provided a theoretical interpretation of this phenomenon through quantum simulations.

The authors of this work started off by studying a simple in-plane heterostructure of graphene and hexagonal boron nitride (h-BN): they embedded a circular graphene region in a monolayer of h-BN, a structure that exhibits a sharp boundary between the two components. By exciting the interface with a laser, they observed a peak of photoluminescence (at 410 nm wavelength), which was not seen instead in the graphene and the h-BN area.

In order to improve the intensity of the photoluminescence, the researchers increased the interface per unit area by preparing in-plane heterostructures of graphene quantum dots (GQD) in a h-BN monolayer. Testing the interface with the same technique, they observed

again a peak of photoluminescence at the same wavelength, but about six times more intense. This result, together with the outcomes of a number of other tests excluding other possible causes of photoemission, proved that the blue light indeed originated from the heterojunction between GQD and h-BN.

The theoretical model provided by Prof. Roche and Prof. Barrios-Vargas supported the results of the experiments, confirming that blue light is emitted, under-stimulation, due to defects in the crystal at the boundary between graphene (or graphene quantum dots) and h-BN. This research is very relevant since it suggests that in-plane G/h-BN heterostructures could be applied for future optoelectronic devices.

Read the original article on Catalan Institute of Nanoscience and Nanotechnology (ICN2).