Hybrid 2D black phosphorus/polymer materials: new platforms for device fabrication.

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Hybrid materials, where a 2D filler is embedded in a polymeric matrix, attracted great interest in past years, because of the wide variety of matrix and filler properties and combinations, the possibility of synergic effect among them, and the easy accessibility to scalable production methodologies. Mostly, the bulk properties of these materials have been studied so far, especially looking at how the filler changes the matrix properties. Here we propose a change in perspective, by using the hybrid material as a platform to exploit the full potential of the filler regarding device applications. In particular, we show results where black phosphorus (bP) flakes are embedded in a poly (methyl methacrylate) matrix. Black phosphorus is a very interesting layered material, thanks to its properties such as in-plane anisotropy of optical and transport properties as well as direct band gap tuneable with layer number. The application of bP has so far been severely limited by its high sensitivity to oxygen, moisture, and light, which increases going from bulk material to thin flakes. We present a low cost scalable method, which involves exfoliation of bulk bP in the monomer and *in situ* polymerization, and which allows to obtain electronic-grade bP nanoflakes, embedded in a polymeric matrix that protects them from the environment and allows their processing into devices without degradation. This research was funded by EU trough the ERC project PHOSFUN (grant n°670173).