2D diamond and diamond-like thinnest films: structures and formation process, properties and application perspectives

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Currently, diamond films, which have a wide range of applications in various fields and technology, are obtained only in the form of micron-sized polycrystals or nano-diamonds (see, for example, [1]). The decrease in thickness is dictated by the miniaturization of elements based on them using the unique properties of the film-meter thickness.

Recently, experimental confirmation was obtained of the formation of the thinnest diamond crystals [2-4], predicted and substantiated by *ab initio* calculations earlier (see in review [5]), called "diamanes" by analogy with a pair of graphene-graphane (or chemical compounds alkenes-alkanes). Diamanes combine the characteristics of a bulk diamond with the features of a 2D material and have a wide band gap, high rigidity and hardness comparable to diamond.

The report provides a review of not only 2D crystals from several covalently bonded graphene layers formed by chemical adsorption of light atoms (H, F, etc.) on two surfaces of a selected molecular FLG (few layered graphene) heterostructure of conventional packing (Bernal-AB, AA or AA'), but also from twisted layers, forming the moire superlattices [5, 6], which are now successfully grown at different angles [7]. In particular, the structure and properties of a new type of 2D quasicrystal [8], formed from a quasicrystal - 30 ° bilayer graphene, are considered.

In addition, the diamandol structures related to diamanes, formed during the chemical adsorption of light atoms or molecules on one side of a FLG, are briefly considered (9, 10). Their feature is the presence of spins on its other side due to the formation of carbon atoms with dangling bonds, in particular, the appearance of a periodic lattice of spins in twisted bigraphene layers.

In addition to graphene, other 2D layers with a hexagonal atomic lattice are also suitable for the creation of such covalently bonded structures. These are, for example, bilayers - graphene and hexagonal boron nitride (G/hBN) and hBN bilayers. Unlike graphene, hBN is a piezoelectric, and its introduction into 2D systems provides a wide change in their electronic characteristics.

A feature of such crystals from molecular ones from 2D layers is their solidity and a significant change in the electronic spectrum, optical, mechanical and thermal properties. It is indicated that the methods for obtaining the considered diamond-like thinnest films are similar to those for obtaining ordinary diamans [2-4, 9].

Prospects for their applications in electronic and optical, optoelectronic mechano- and thermoelectric nanodevices are considered: in particular, Dn-sensitive resonators, semiconductors with a tunable band gap, new types of field-effect transistors, Dn in systems of magnetic resonance imaging and quantum optics (see. references in reviews [5,10]).

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