SYNTHESIS of graphane in plasma jet reactor

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Among carbon materials graphene attracts attention, which is a single monatomic layer of carbon atoms. Due to the unique structure of the unit cell, graphene demonstrates unique mechanical, optical and electronic properties. However, semimetallic nature of conductivity of graphene makes it difficult to real use in semiconductor electronics. One of the promising directions in basic research and technological applications of graphene is a chemical modification of graphene to modify its electronic structure. Hydrogenation allows you to change the parameters of the band gap, making graphene in real semiconductor or insulator. Hydrogenated graphene can be used to store hydrogen or find application in fuel cells [1]. To date, it was demonstrated the possibility of the successful hydrogenation of graphene using a nonequilibrium hydrogen plasma [2], the beams of hydrogen atoms, the electron-induced dissociation of hydrogen-silsesquioxane [3], the Birch processes [4]. Used for hydrogenation graphene preformed by mechanical cleavage of [2] or CVD-method [3]. For hydrogenation usually used graphene preliminary obtained by mechanical cleavage of [2] or CVD-method [3].

We have shown the ability to direct synthesis of hydrogenated graphene materials in a plasma jet reactor [5]. The samples materials obtained by the decomposition of carbon precursors (hydrocarbons) using the DC plasma torch with power up to 45 kW at a pressure below atmospheric pressure. The methane, acetylene, butane, and propane are used as hydrocarbons. We used helium and argon as the plasma forming gas. Elemental analysis, scanning electron microscopy, Raman spectroscopy and X-ray photoelectron spectroscopy showed that in the synthesized samples with few layers atomic hydrogen to carbon ratio reached 1 : 4.

The dependence of the degree of hydrogenation from the parameters of the plasma jet and the target geometry was found. Calculations of chemical kinetics showed the presence in the plasma jet a high concentration of atomic hydrogen in the nucleation zone of carbon vapor. If the samples are heated the hydrogen evolution was observed, that was confirming by the thermogravimetry in argon up to a temperature of 1500°C.

It was concluded that the direct synthesis graphane in a one step in the plasma jet reactor is possible.

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