Raman spectra of nitrogen- and boron-doped carbon dots

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The term “carbon dot” implies a nano-sized carbon particle. The common methods of synthesizing CDs, such as hydrothermal and solvothermal methods, contribute to the formation of a crystalline carbon nucleus. The crystalline carbon core larger than 10 nm obtained by such methods does not correspond to a single-layer graphene flake and, in particular, can be a multilayer graphene flake. In this work, we call a carbon dot a certain nanometer-sized particle that has a thickness of 1–4 graphene layers and has functional groups on the surface and at the edges [1].

Synthesis of CDs is simple and does not require the use of expensive equipment, and the raw materials are affordable and cheap. The hydrothermal synthesis method is based on the high solubility of a large amount of organic matter in water at high temperature and pressure, and the possibility of subsequent crystallization of the dissolved material from the liquid phase. The control of vapor pressure, temperature and reaction time provides ample opportunities for the synthesis of high-quality CDs [2].

We report a simple synthesis of two types CDs using the hydrothermal treatment method. The goal of investigation of Raman spectroscopy of obtained CDs is to provide insight into the influence of the organic precursor (citric acid and ascorbic acid) on the properties of structure of the CDs. Besides, during synthesis CDs were doped by nitrogen and boron because N- and B-doped CDs can be used for many optoelectronic devices [3]. The N dopant can inject electrons [4] and B dopant can inject holes into carbon-based materials, thus changing the electronic and transport properties. The resulting CDs have a crystalline structure with functional groups on the surface and exhibit bright photoluminescence in the violet–green region of the spectrum. These synthesized CDs consist mostly of 1–4 layers having a uniform size of about ~10 nm, and the nitrogen and boron atoms were successfully introduced into the lattice of CDs.

Fig. 1 shows the Raman spectra of CDs and graphene oxide (suspension of graphene oxide was synthesized using the modified Hammers method, rather than the hydrothermal method). The identity of the spectra indicates that the CDs are small-sized flakes of graphene oxide. We identified that the ratio of I_d/ I_g peaks changes while the synthesis characteristics change as the processing time and the initial composition of precursors.

The obtained results are useful for understanding the formation of the structure of CDs for further application in various applications of optoelectronics.

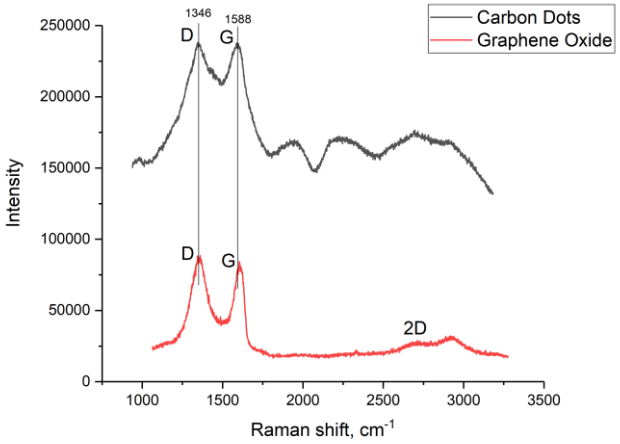

Fig. 1. Raman spectra of nitrogen-doped carbon dots (black line) and graphene oxide (red line).

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