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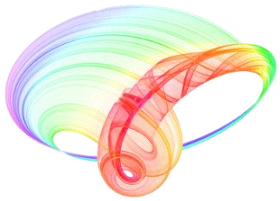

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VIII International School and Conference on Photonics

& HEMMAGINERO workshop

23 - 27 August 2021,

Belgrade, Serbia

Editors

Mihailo Rabasović, Marina Lekić and Aleksandar Krmpot

Institute of Physics Belgrade, Serbia

Belgrade, 2021

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Enhanced photoluminescence of gamma-irradiated S, N graphene quantum dots

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Zero-dimensional graphene quantum dots (GQDs) are one of the most promising luminescent carbon-derived nanomaterials with different oxygen-containing functional groups on their surface. They consist of one or few layers of graphene and have a lateral dimension below 100 nm. Some of their distinct and superior physical and chemical properties such as tunable photoluminescence, good biocompatibility, low toxicity, and excellent dispersibility in water, make them a promising candidate for biomedical applications [1]. With the functionalization of GQDs, it is possible to modify their surface structure by adding other functional groups thus altering photoluminescence and enhancing their other properties [2]. Gamma irradiation proved to be a simple and eco-friendly method for subsequent modification of carbon nanomaterials [3, 4].

Here, we present a simple, one-step method for functionalization of GQDs with gamma irradiation in the presence of amino acid L-cysteine as an S, N heteroatom donor and isopropyl alcohol as a radical scavenger. Water dispersion of GQDs with 1 vol% isopropyl alcohol and 2 mass% of L-cysteine was purged with Ar gas for 15 minutes and then exposed to gamma irradiation at doses: 25, 50 and 200 kGy. The optical and structural properties of obtained S, N-GQDs were investigated using Ultraviolet-visible spectroscopy (UV-Vis), Fourier-Transform Infrared spectroscopy (FTIR), Photoluminescence spectroscopy (PL), Atomic force microscopy (AFM) and Dynamic light scattering (DLS). Successful doping of S and N heteroatoms in the structure of irradiated GQDs was confirmed with FTIR analysis through detected S-H, C=S, and N-H stretching vibrations. Also, an improvement in photoluminescence quantum yield (QY) has been proved by PL measurements. The best result was achieved for the sample irradiated with a dose of 25 kGy. PL QY of this sample was 15 times higher compared to non-irradiated p-GQDs, and around 7 times higher up against other irradiated samples. Both AFM and DLS measurements were in correlation and indicated that gamma irradiation increased the layer separation and overall particle diameter of GQDs. The average diameter ranged from 25 nm up to around 30 nm for irradiated samples while the diameter of non-irradiated p-GQDs was 20 nm.

The proposed one-step chemical doping provided an improvement in one of the most characteristic features of GQDs- photoluminescence, as well as in morphological properties. Due to this, the obtained S, N-GQDs have great potential for application in medicine as a bioimaging agent.

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