

The influence of pH on the photoluminescence of carbon dots with different surface functionalization

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To create new nanomaterials and their effective application in biomedicine, it is necessary to be able to observe them in a biological environment. One of the main approaches to solving this problem is optical imaging, which provides for the presence of stable intense photoluminescent properties of nanoparticles. Recently, for this purpose, carbon dots (CDs) have been actively studied. CDs are a class of carbon nanomaterials that exhibit a unique combination of optical and chemical properties, such as stable photoluminescence (PL), nontoxicity, biocompatibility, etc.

Despite the active development of studies of the CDs photoluminescent properties and their dependence on environmental parameters (pH, temperature, the influence of surrounding ions/biomacromolecules, etc.), there are still open questions about specific mechanisms that cause certain changes in the PL spectra of CDs suspensions. There are conflicting data in the literature describing changes in the PL spectra of CDs suspensions with a change in the pH of the medium.

In this research, aqueous suspensions of CDs, synthesized by the hydrothermal method from aqueous solutions of citric acid and ethylenediamine and further functionalized with carboxyl and hydroxyl surface functional groups, were studied. A significant influence of the medium acidity of nanoparticles on their photoluminescence was found as a result of studying the optical and colloidal properties of CDs with different surface functionalization. It was found that the greatest changes in the spectral characteristics of the PL of CDs with carboxyl and hydroxyl surfaces appear in the same pH ranges of 2–5 and 8–12, corresponding to the pK_a ranges of carboxyl, hydroxyl, and amide functional groups. The results are explained by the processes of protonation/deprotonation of the CDs surface groups -COOH, -OH, and -NH₂, which is confirmed by the dependences of the CDs zeta potentials and sizes on the pH of aqueous suspensions.

The study was carried out at the expense of the Russian Science Foundation No. 22-12-00138, <https://rscf.ru/project/22-12-00138/>.