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## Nonlinear optical properties of colloids with carbon nanoparticles

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### Abstract

Experimentally studied linear and nonlinear characteristics of colloid on the basis of a new class of carbon nanoparticles (CN) synthesized by hydrothermal synthesis. The spectral characteristics of supercontinuum of the colloids with CN in the range 420 - 700 nm were investigated. The effectiveness of excitation of one- and two-photon fluorescence colloids with UN was determined. The anomalous dependence of the nonlinear refractive index of the wavelength of the radiation was revealed. It was installed that the efficiency of spectral transformation of the supercontinuum process in the case of colloid with carbon nanoparticles is less in the anti-stokes region than in case with water.

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*Keywords:* colloids with carbon nanoparticles; nonlinear optical properties; supercontinuum

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### 1. Introduction

The carbon quantum dots (CQD) are a new class of carbon nanoparticles. CQD is treated as a special transitional state of carbon, different from the known - graphite, graphene, carbon nanotubes, fullerenes and nanodiamonds (Baker S.N. and Baker G.A. (2010), Li H.T. et al. (2012), Shen J. et al. (2012)). They were first obtained in the course of purification of single-walled carbon nanotubes using electrophoresis preparation in 2004 year (Xu X. et al. (2004)), and then by laser ablation of graphite powder in 2006 (Y.-P. Sun and B. Zhou (2006)). CQD are discrete

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carbon nanoparticles, such as nano-diamonds. However, as a nearly spherical shape and having dimensions of no more than 10 nm, CQD fundamentally different from them (Bourlinos A.B. et al. (2012)). One of the interesting features of the CQD are their photoluminescent properties, discussed in (Xu X. et al. (2004)). Also widely studied such properties of C-dots, as photo-induced electron transfer and redox properties (Wang X. et al. (2009)) and biocompatibility (Yang S.-T. et al. (2009)). Due to its unique properties and great potential for various applications CQD are increasingly used in biomedicine, optronics, catalysis, biosensors, etc.

Nevertheless, in spite of their unique optical properties nonlinear optical characteristics of CQD have not been studied enough and studies were conducted only for the nano- and picosecond (Aloukos P. et al. (2014)). Therefore, the aim of this work is the study of optical and nonlinear optical properties of colloids of CQD in the case of excitation femtosecond laser pulses and determining the conversion efficiency in the spectrum of supercontinuum in the range of 420-700 nm.

## 2. Experiment and results

For research from plant material were prepared sample colloid with CQD by hydrothermal synthesis with dimensions less than 10 nm. As the laser light source used laser complex Spitfire 40f-1k-5W (Spectra Physics). With this setup generated pulses of about 45 fs with a central wavelength of 800 nm and a half-width of the spectrum  $\Delta\lambda_{FWHM} = 35$  nm. The beam diameter was 6 mm. The pulse repetition rate can range from 50 to 1000 Hz, depending on the experimental conditions. For the second harmonic generation used a parametric converter Spectra Physics. In this case, the pulse duration was about 85 fs.

The resulting transmission spectrum of the sample is shown in Fig. 1.

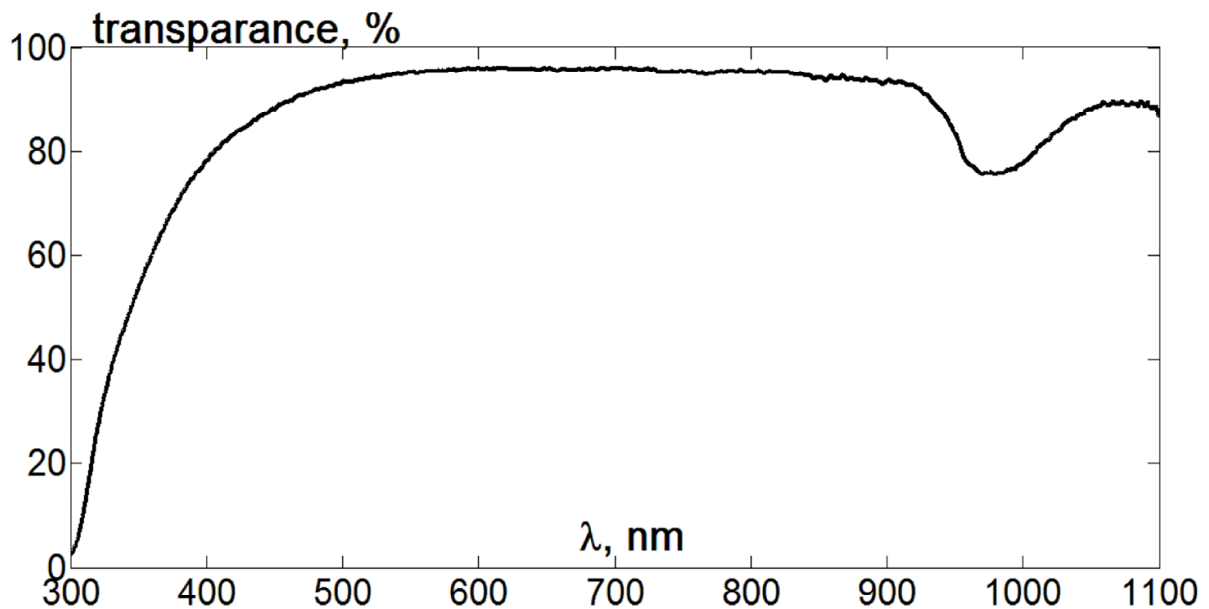


Fig. 1. The transmission spectrum of the sample colloid CQD.

According to the got data sample of the colloid with CQD is transparent in the optical wavelength range. With decreasing wavelength ultraviolet region observed a significant increase the absorption coefficient.

Spectra of one- and two-photon fluorescence of the investigated material are shown in Fig. 2.

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