Hybrid structures of shungite nanocarbon

N.N. Rozhkova, S.S. Rozhkov, A.A. Mikhailina
Institute of Geology Karelian Research Center
185910 Petrozavodsk, Russia
rozhkova@krc.karelia.ru

Abstract—Primary globular clusters in aqueous dispersion of shungite nanocarbon are formed of nonplanar graphenes kept together due to the confined water. The aqueous dispersion was used in preparation of shungite nanocarbon hybrids

Keywords—graphene, shungite nanocarbon, hybrid structures

I. GRAPHENE DISPERSIONS

The subject of graphene investigations concerned the quantum size effects, manifested in the spin, electronic and optical properties of the graphene fragments. With the growth of interest in graphene quantum dots, the question arose of their preparation. With the recent burst of activity surrounding the solution-phase production of graphene, rather little progress has been made toward the generation of graphene dispersions with tailored thickness, lateral area, and shape. In all cases the graphene clusters are not single-layer domains, and are multilayer formations containing up to 10 layers of reduced graphene oxide of less than 30 nm in size. Optical layer formations containing up to 10 layers of reduced graphene clusters are not single-layer domains, and are multilayer formations containing up to 10 layers of reduced graphene oxide of less than 30 nm in size. Optical spectrosclopy, photoluminescence (PL), in particular, was the primary method of studying the properties of the graphene in dispersion [1].

Among the main features of the graphene dispersions there are its structural inhomogeneity, dependence of the graphene clusters PL spectrum on the solvent; dependence of the PL spectrum on the excitation light wavelength.

II. SHUNGITE GRAPHENE IN DISPERSIONS

Otherwise clusterization of graphene flakes in the stable aqueous dispersion of shungite carbon nanoparticles, prepared by processing of natural carbonaceous raw material (shungite) in water was well reproducible process [2]. As shown in [3] graphene quantum dots present the main structural peculiarity of shungite nanocarbon that is presented as a multistage fractal nets of reduced graphene oxide fragments of less than 1 nm in size. The condensation of the aqueous dispersion was accompanied by the aggregation of nanoclusters followed by the formation of a 3-dimensional net with nodules in the form of distinct globules coinciding in size with the clusters in the dispersion detected by dynamic light scattering. The globules are formed of nonplanar graphene fragments, kept together due to the confined water [4]. Substitution of water by non-polar molecular solvents drastically changes the size and structure of aggregates. Globules were transformed into stacks and flakes of different area that are detected in microscopic study (SEM and TEM).

Photonic of shungite dispersions faces the problem that big statistical inhomogeneity inherent in the quantum dot as an object of the study makes it difficult to interpret the results in details. The recent study confirms the earlier findings that graphene-like structures of limited size, namely, reduced graphene oxide fragments are the basic structural elements for all shungite nanoparticles dispersions. The second feature concerns the dependence of the position and intensity of selective PL spectra on the exciting light wavelength $\lambda_{exc}$. This feature lies in the fact that regardless of the composition and solvent of dispersions the PL excitation at $\lambda_{exc}$ 405 and 457 nm provides the highest PL intensity while excitation at eightier longer or shorter wavelengths produces a much lesser intensity of the emission. The answer to this question were attributed to nanoscale fragments of reduced graphene [5].

Obviously, the reverse procedure of the shungite dispersing in water is statistically also nonuniform with respect to colloidal aggregates so that there is a strong dependence on the technological protocol. This, in a sense, a kinetic instability of dispersing, is the reason that the composition of colloidal aggregates can vary when water is displaced by other solvent. The conducted spectral studies have confirmed these assumptions.

The aim of the present study was to construct hybrid materials using the reorganization of shungite nanocarbon structure in the stable aqueous dispersion. Similar structures, namely shungite nanocarbon – silica were picked up in the natural shungites. Its structural and physical chemical properties would be discussed.


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