

VIII Международная конференция с элементами научной школы для молодежи

«ФУНКЦИОНАЛЬНЫЕ НАНОМАТЕРИАЛЫ И ВЫСОКОЧИСТЫЕ ВЕЩЕСТВА»

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В сборнике материалов опубликованы доклады VIII Международной конференции с элементами научной школы для молодежи «ФУНКЦИОНАЛЬНЫЕ НАНОМАТЕРИАЛЫ И ВЫСОКОЧИСТЫЕ ВЕЩЕСТВА», содержащие результаты фундаментальных исследований в области наук о материалах и оценку экономической эффективности использования инновационных разработок. Затронуты вопросы, связанные с разработкой и созданием наноматериалов функционального назначения, в том числе металлических, особо чистых, керамических, полимерных и композиционных. Сборник предназначен для научных работников, специалистов, аспирантов, работающих в области наук о материалах, а также может быть полезен студентам старших курсов высших учебных заведений.

Конференция поддержана:

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INTER-PLANE DISTANCES AND SORPTION – REPRODUCIBLE CHARACTERISTICS OF NON-UNIFORM IN STRUCTURE AND COMPOSITION OF GRAPHITE OXIDE POWDERS <u>Avramenko N. V.,</u> Parfenova A. M., Rebrikova A. T., Usoltseva L. O., Mikheev I. V., Volkov D. S., Senyavin V. M., Korobov M. V.

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Very strong interest was recently attracted to multilayered GO materials obtained by deposition of graphene oxide sheets using water and polar solvent solutions: thin films, papers, and membranes. Sorption and inter-plane distances were shown to be reproducible characteristics of graphite oxide's H-GO and B-GO powders, though these powders are non-uniform in structure and composition. Sorption of Hummers and Brodie graphite oxides in several common liquid solvents was quantitatively estimated for ambient temperature and temperature points of solvent melting. The sorption of all studied solvents was found to be stronger for Hummers compared to Brodie graphite and for all studied systems to be higher at lower temperature. The lastmentioned result opens up possibilities to separate graphene oxide is remarkably similar if expressed in volumetric units (cm³/g) thus demonstrating that at equilibrium sorption into graphite oxide structure is controlled by limitations of available inter-layer volumes (lattice expansion) rather than by the number of available adsorption sites which would be the case if molar uptakes were similar. Sorption of water vapors was compared for Hummers graphite oxide and multilayered membrane sample revealing certain difference at higher humidity levels.

Thermodynamic approach was used to account for Hummers and Brodie graphite oxides sorption/swelling in polar organic solvents and water. This is a complex process sensitive to the way of material preparation and to the pre-history of the samples studied. Even if complete equilibrium in these systems is likely not achievable in our experiments, it was demonstrated that thermodynamic considerations can be used to describe characteristic temperature and pressure behavior of graphite oxide/solvent systems. The swollen materials were considered to be solid solvates of graphite oxides and the two distinct types of their temperature behavior were explained within the concept of narrow or wide homogeneity ranges of the corresponding solvates. One and the same thermodynamic routine were used to account for temperature and pressure maximums of sorption/swelling at the points of phase transitions of the solvents. The equilibrium data on sorption were found useful in considering the rate of water permeation through the Hummers oxide membrane. Simple linear dependence of the permeation rate over sorption was estimated.

Clearly sorption/swelling of graphite oxide in our experimental conditions may proceed under thermodynamic rather than kinetic control. With more experimental data at hand we hope to extend this thermodynamic consideration into the sorption properties of different graphene oxide materials.

Sorption properties of Brodie graphite oxide (B-GO) were studied for the series of normal alcohols from methanol to 1-nonanol using Differential Scanning Calorimetry, Thermogravimetry, isopiestic method and X-ray diffraction. It was demonstrated that the sorbed polar liquids form parallel layers in between the B-GO planes. The layers typically described by the increase of the inter-plane distances now were characterized by the value of sorption. Sorption capacity of one layer was found to be the same for rather different liquids. The best measure of sorption capacity was specific volume of sorbed liquid rather then corresponding number of sorbed moles per gram of B-GO. Specific volume rather than numbers of moles was shown to be adequate characteristic of a layer. This points to non stoichiometric nature of sorption of polar liquids into GO.

One layer occupied approximately 45% of the geometrical surface of the B-GO plane, leaving plenty of empty space evaluable for the diffusion within the swelled structures. Although the swelled B-GO structures could not be considered normal chemical compounds, their properties were successfully described using routine concepts of chemical thermodynamics. Several equilibrium swelled structures with different number of sorbed layers found in the system B-GO / 1-nonanol and B-GO / 1- octanol were adequately represented by binary phase diagram. The abrupt desorption of layers with the increase of temperature in the systems were considered to be incongruent melting phase transitions.

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