New findings on the structure of graphite oxides in alcohols

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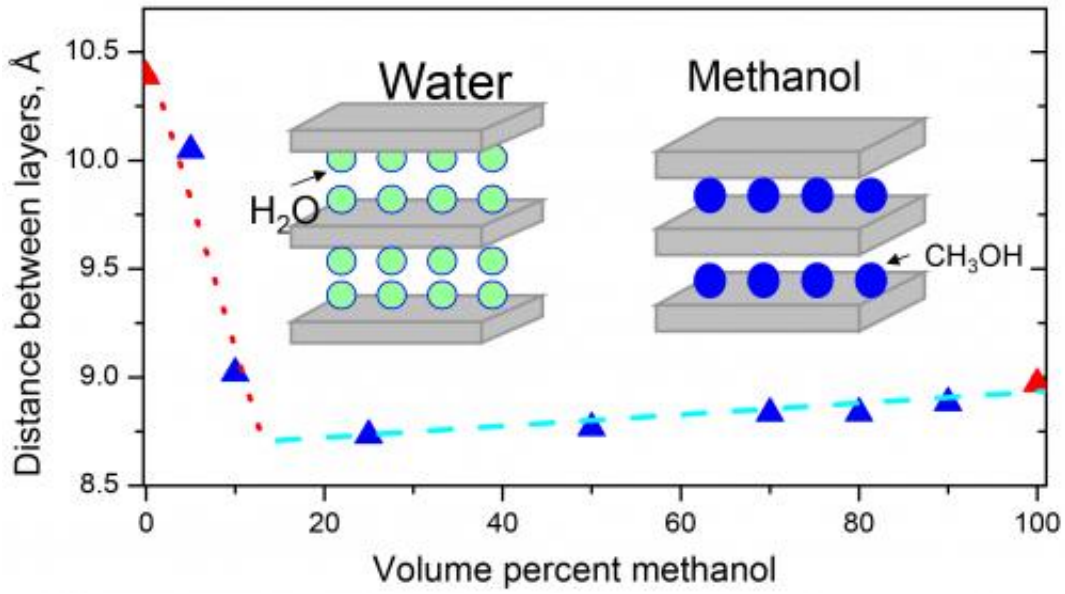

(Phys.org)—The structure of graphite oxide surprisingly expands when cooled in methanol or ethanol. Also, graphite oxide selectively absorbs methanol from water-methanol mixtures. Two new studies by physicists at Umeå University in Sweden, published in *ACS Nano* and *J. Phys. Chem. C*, respectively, provide knowledge on new properties of oxidized graphite and graphene.

Graphene is a two dimensional material consisting of a single layer of

carbon atoms arranged in a honeycomb structure. Graphene can be considered as a unique adsorbent material due to its extremely large surface area. One gram of graphene has a surface area comparable to a football field. This surface could be used for adsorption of gases and liquids, in applications for gas storage, extraction of pollutants from water, etc. However, the graphene is hydrophobic, which means that its surface repels water.

On the other hand, oxidation of graphene results in remarkable changes in its properties. Graphene oxide is hydrophilic and it is also easily soluble in water. A material composed of many stacked graphene oxide layers is called graphite oxide. It has many unique properties: it absorbs water and alcohols in large amounts, similar to clays that swell when water is added.

A new study by Alexandr V. Talyzin and his team reveals that graphite oxide is able to incorporate even more methanol and ethanol at low temperatures compared to room temperature. Its structure expands when cooled in an excess of liquid solvent. At -130 degrees Celsius the graphene oxide layers are separated by 20.4 Å due to incorporation of additional ethanol into its structure, compared to approximately 3.4 Å in natural graphite and approximately 6.5 Å in solvent-free graphite oxide.

"The distance between graphene oxide layers at low temperatures is so large that it becomes a composite material with graphene oxide sheets separated by at least four monolayers of methanol or ethanol molecules. What is also remarkable is that this phenomenon is limited only to one specific type of graphite oxide and is not observed in another type studied. In fact, many different kinds of graphite oxide are known and now we start to understand how enormous the variations of their properties are. It is not just one material, it is a whole family of materials," says Alexandr V. Talyzin, researcher at the Department of Physics.

In a separate study published in *J. Phys. Chem. C* it was demonstrated that a certain type of graphite oxide can be used for selective absorption of methanol from water-methanol mixtures. A very simple prototype filtering experiment showed that when a water-methanol liquid mixture is passed through graphite oxide powder, some of the methanol is absorbed in the powder and the solution passing through contains more pure water.

"In the future we would like to design special membranes composed of graphene oxide layers, which can be used for separation of different solvents and purification of water. These first results help us to understand possible ways to make such membranes," says Alexandr V. Talyzin.

The first example of successful solvent separation effects was reported last year in a study by R.R. Nair et al. from a research team at Manchester University, lead by I.Grigorieva and Nobel Laureate A. Geim, famous for their research in the graphene field.

More information: You, S. et al. Enormous Lattice Expansion of Hummers Graphite Oxide in Alcohols at Low Temperatures. *ACS Nano*, Article ASAP. DOI: 10.1021/nn3051105

You, S. et al. Selective Intercalation of Graphite Oxide by Methanol in Water/Methanol Mixtures. *J. Phys. Chem. C*, Article ASAP. DOI: 10.1021/jp312756w

Provided by Umea University