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M. Sc. Industrial Chemistry

Industrial Chemistry Department



Water transformed into shiny, golden metal

Water conducts electricity - but this refers to "normal" everyday water that contains salts. Pure, distilled water, on the other hand, is an almost perfect insulator. It consists of H_2O molecules that are loosely linked to one another via hydrogen b onds. The valence electrons remain bound and are not mobile. To create a conduction band with freely moving electrons, water would have to be pressurised to such an extent that the orbitals of the outer electrons overlap. Turning water into a metal in this way would require an expected 15 million atmospheres of pressure, which is out of reach for current lab techniques. However, a calculation shows that this pressure is only present in the core of large planets such as Jupiter.

Experimental

A collaboration of 15 scientists from eleven research institutions has now used a completely different approach to produce an aqueous solution with metallic properties for the first time, experimented with alkali metals, which release their outer electron very easily as shown in figure 1.



Figure: 1



Figure: 2

However, the chemistry between alkali metals and water is known to be explosive. Sodium or other alkali metals immediately start to burn in water. A piece of alkali cannot be thrown into water, but put a tiny bit of water on a drop of alkali metal, a sodium-potassium (Na-K) alloy, which is liquid at room temperature.

Set up the experiment in the high vacuum sample chamber as shown in figure: 2. Sample chamber contains a fine nozzle from which the liquid Na -K alloy drips. The silver droplet grows for about 10 seconds until it detaches from the nozzle. As the droplet grows, some water vapour flows into thesample

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Figure: 3

chamber and forms an extremely thin skin on the surface of the droplet, only a few layers of water molecules. This almost immediately causes the electrons as well as the metal cations to dissolve from the alkali alloy into the water. The released electrons in the water behave like free electrons in a conduction band.

Golden water skin

The silvery sodium-potassium droplet covers itself with a golden glow as shown in figure: 3, which is very impressive. The thin layer of gold-coloured metallic water remains visible for few seconds. It is indeed water in a metallic state.

Fingerprints of the metallic phase

The two decisive fingerprints of a metallic phase are the plasmon f requency and the conduction band. To determine these two quantities using optical reflection spectroscopy and synchrotron X-ray photoelectron spectroscopy: While the plasmon frequency of the gold-coloured, metallic "water skin" is about 2.7 eV (i.e. in the blue range of visible light), the conduction band has a width of about 1.1 eV with a sharp Fermi edge. "Study not only shows that metallic water can indeed be produced on Earth, but also characterises the spectroscopic properties associated with its beautiful golden metallic luster.

Reference: Mason, P. E. et al. Nature Chem. 7, 250-254 (2015).

Parag J Babariya 20IC67

Sweet Words from Family

"It is a matter of pride and honour for me to write a few lines about the IC department. It is not just an academic functioning department, it's a home for holistic development for their stakeholders, which includes, knowledge gaining, knowledge dissemination, training and absorbance to corporate sector".

Dr. Mehulkumar L. Savaliya (2010-2012) Assistant Professor Department of Industrial Chemistry Atmiya University Rajkot-Gujarat, INDIA.

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