Molecular 'propellers' may rotate very slowly

(Nanowerk News) The experiments conducted in the Institute of Physical Chemistry of the Polish Academy of Sciences on super-thin liquid-crystal films created on water surface allowed the surprisingly slow and continuous rotational motion of molecules, rotating "in unison", to be observed nearly with the naked eye.

Scientists from the Institute of Physical Chemistry of the Polish Academy of Sciences (IPC PAS) established that in the liquid-crystal layers that are several nanometers thick and created on water surface, molecules may rotate with extremely low speed, just one revolution per several minutes. Such slow rotational motion is a real surprise since it was expected that rotation would be quickly destroyed by thermal fluctuations. "We do something similar but on a smaller scale: we spill microlitres of liquid crystal on water surface. Its molecules form a monolayer, that is a layer which is one-molecule thick," explains PhD Andrzej Zywołowski from the IPC PAS.

Molecules of the liquid crystals that are examined have amphiphilic character – the hydrophilic group of a chain attaches to water surface, over which the hydrophobic tail protrudes making dissolution impossible – and they freely move across the water surface, which means they behave like gas in two-dimensional space. However, researchers were interested in the behaviour of liquid crystals in a liquid phase. A gas may be transformed into a liquid or solid as a result of changes in temperature or pressure. If we use the latter, solidification is achieved at high pressures of at least several dozens of atmospheres. Fortunately, in the case of monolayers a suitably high pressure can be easily obtained with a device called the Langmuir balance. It is a shallow tank filled with water, with two hydrophilic barriers between which there is a gas phase.
Slowly rotating molecules of liquid crystals can be used to construct nanodevices. "It is possible to construct a molecule in which a group of atoms playing the role of a sail would be a kind of a nanodrive. Then we would create a real molecular nanogenerator driven by a water vapour stream," says Zywoceński, and he adds that scientists are now working on the possibility to transfer this collective rotation of single molecules to larger objects.

The Institute of Physical Chemistry of the Polish Academy of Sciences (http://www.ichf.edu.pl/) was established in 1955 as one of the first chemical institutes of the PAS. The Institute's scientific profile is strongly related to the newest global trends in the development of physical chemistry and chemical physics. Scientific research is conducted in nine scientific departments. CHEMIPAN R&D Laboratories operating as part of the Institute implement, produce and commercialise specialist chemical compounds to be used, in particular, in agriculture and pharmacy. The Institute publishes approximately 300 original research papers annually.

Source: Institute of Physical Chemistry of the Polish Academy of Sciences

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