Blowing bubbles on a nanoscale

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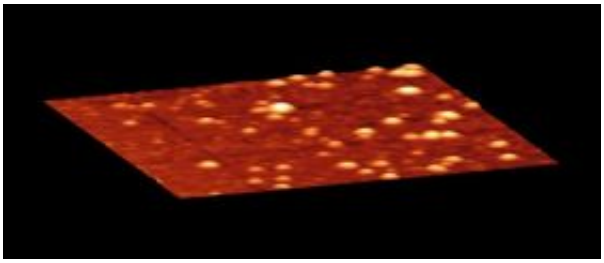

A 3-D visualization of nanobubbles present on a hydrophobic surface. The bubbles have a diameter of only 50-200 nanometres and a thickness of 5-20 nanometres. Image: University of Twente

(PhysOrg.com) -- Scientists are puzzled by the nanobubbles that can develop on surfaces under water. It should be impossible for them to exist but nevertheless they remain intact for hours. They are something of a mystery, yet it is possible to manipulate the development of these bubbles, according to PhD candidate Shangjiong Yang at the University of Twente, Netherlands. The bubbles can then, for example, be used to reduce flow resistance in liquids. Yang received his doctorate from the Faculty of Applied Sciences on 9 October.

If a water-repellent material is submerged in water, nanobubbles can develop on its surface: extremely small air bubbles with a diameter of 50-200 nanometres and a thickness of 5-20 nanometres. These bubbles are so small they cannot even be seen with a normal microscope and that is why they were not discovered until a few years ago.

According to existing theories, these bubbles should really not exist at all, as the pressure inside them is so great that the gas they contain should be pressed out within a fraction of a second. It is still not understood why these bubbles can remain intact for hours. Once it is possible to manipulate the formation and properties of these bubbles, a whole range of applications becomes possible.

For example, the frictional resistance of flowing liquids is reduced by the bubbles, thus enabling them to be used as a lubricant in extremely narrow channels. This is of practical use in the development of the so-called 'labs-on-a-chip': a whole laboratory set-up, reduced to the size of a chip. Before these bubbles can be employed in this way, however, we have to understand them better and be able to determine exactly where they should develop.

Production of nanobubbles

Yang demonstrated that electrolysis is a reliable method for controlling the production of nanobubbles. He discovered a way of influencing the formation and size of the bubbles by applying a voltage. He also researched several fundamental properties of the bubbles. After all, before you can use them you have to understand them. That is why he investigated the influence of temperature, gas concentration, the roughness of the surface and the surface treatment method on bubble formation.

Yang made use of the Atomic Force Microscope (AFM) when carrying out his investigation. It is a microscope with a minuscule needle that moves over the surface (just like the needle of a record player) and monitors differences in height. This needle was used not only to investigate the outlines of the bubbles but also to manipulate them.

Shangjiong Yang (1980, Chongqing, China) carried out his PhD research

with the specialist groups Physics of Fluids and Solid State Physics in the Faculty of Applied Sciences at the University of Twente. Professor Detlef Lohse and Professor Harold J.W. Zandvliet supervised his research.

Provided by University of Twente, Netherlands