Researchers discover that the constant angle of curvature is the reason that nanobubbles are stable

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If a water repellent substrate is immersed in water containing dissolved gas, tiny bubbles can form on the immersed body. These so called surface nanobubbles emerge because the surrounding liquid wants to lose its gas, similar as bubbles emerge in a glass of soda. In the case of the nanobubbles, however, the bubbles are only ten to twenty nanometres in height, and therefore the (Laplace) pressure in the bubble is very high.

According to all the current theories, the bubbles should disappear on their own accord in less than a millisecond, since the gas in the bubbles wants to dissolve in the water again. According to Lohse, this idea is quite similar to a balloon, which - even if it is properly tied - always deflates over time. The reason for this is that a little bit of air constantly leaks through the rubber of the balloon due to diffusion and the high pressure in the balloon.

In practice, however, the nanobubbles can survive for weeks, as was already observed more than twenty years ago. Nevertheless, scientists failed to find a conclusive explanation for this long lifetime. With the publication of an article in the scientific journal *Physical Review E* (Rapid Communication), prof. dr. ir. Detlef Lohse and prof. dr. Xuehua Zhang (who besides the UT is also affiliated with the RMIT University in Melbourne) finally provide an explanation for the phenomenon. And they do this with a complete analytical method with relatively simple mathematical formulas.

The reason that the bubbles survive for such a long period of time lies in the pinning of the three phase contact line. Thanks to the pinning, bubble shrinkage implies an increase of the radius of curvature and thus a smaller Laplace pressure. For stable bubbles the outflux originating from the Laplace pressure and the influx due to oversaturation balance. The result is a stable equilibrium.

The research not only provides an answer to a fundamental physical and chemical question, but also has all sorts of practical applications. The knowledge can, for example, be used to make catalytic reactions more efficient and for flotation processes, a purification technique that is used a lot in the extraction of minerals.

Within his Physics of Fluids (POF) Department at the University of Twente, Lohse has already been working on this topic for more than ten years. In this research, he works closely with prof. dr. ir. Harold Zandvliet from the Physics of Interfaces and Nanomaterials (PIN) department. The research is part of the MCEC Gravity Programme, within which the University of Utrecht, the Eindhoven University of Technology and the University of Twente work together on the development of efficient catalytic processes for different energy and material resources, such as fossil fuels, biomass and solar energy. NWO is financing this programme with 31.9 million euros.

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