Fundamental Properties and Technical Applications of Micro and Nano-bubbles

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We are very familiar with gas bubbles in liquid phase. The shining bubbles in beer stimulate our thirsty, and bubbles in aquariums can supply enough oxygen for living-creature in the water. Now we are realizing outstanding functions that tiny bubbles have in aqueous solution, and these bubbles are called microbubbles and nanobubbles.

Microbubbles are spherical gas bubbles less than 50 μm in diameter and can be generated directly by specific nozzles in aqueous solutions. They are shrinking underwater and eventually disappear. During the collapsing process of the tiny bubbles the shrinking gas-water interface provide the bubbles several important properties, such as the increase in interior gas pressure and the generation of free-radicals. The pressure increase is caused by the effect of surface tension, and the latter is related to the electrical property of the tiny bubbles.

Electrophoresis observations reveled that microbubbles are negatively charged over a wide range of pH conditions and the surface electricity is accumulating to the contracting interface of the shrinking microbubble. And we are realizing that the property causes the very intriguing functions, free-radical generation and stabilization of bulk nanobubbles.

Microbubble can generate the hydroxyl radicals without any harsh dynamic stimulus. Since the radical is one of the strongest oxidant in water we can use the tiny bubbles for several technical purposes, such as wastewater treatment and semiconductor cleaning. And the electrical property of collapsing microbubbles in an electrolyte solution causes the generation of stabilized nanobubbles.

Nanobubbles are considered to be spherical nano-particles in aqueous solution with specific functions useful for practical purposes in a wide variety of technical fields, such as agriculture, medicine and engineering. And we successfully produce many kinds of nanobubbles, such as oxygen, ozone and carbon dioxide.

At the international symposium, practical examples of microbubble and nanobubble are also introduced as well as the fundamental properties

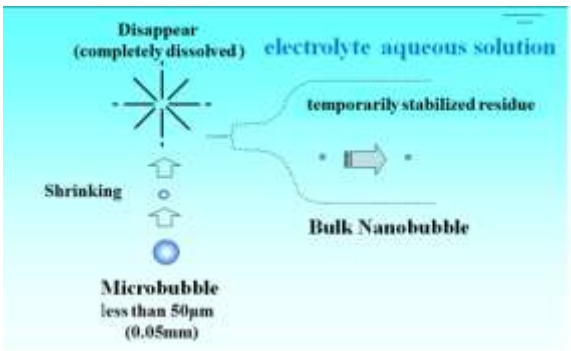

Fig.1 Definition of micro & nanobubble

Microbubble is a tiny bubble that shrinks underwater. Bulk nanobubbles may be the temporarily stabilized microbubble residues due to the effect of the surface electricity.

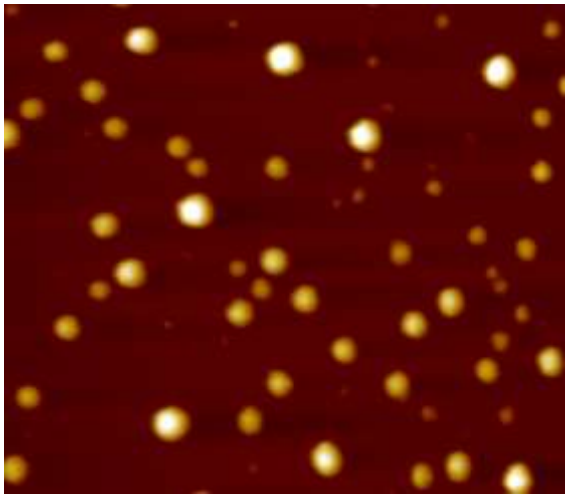

Fig.2 AFM observation of ozone nanobubbles

The image of Atomic Force Microscopy (AFM) shows that the spherical ozone nanobubbles have the size distribution aroud 20 nanometers. Ozone nanobubbles have a very strong disinfection ability, but its astonishing properties are very weak toxity to our human cells.