ROBERT CAMERON

Professor Masatoshi Takahashi, seen here with a microbubble generator, has big plans for nanobubbles generated using a proprietary technique.

Tiny Bubbles

In an aquarium in Prof. Masatoshi Takahashi's office in Tsukuba, a dozen fish – carp, goldfish and sea bream – swim happily together. This is impossible. Goldfish and carp are freshwater fish, and the bream is from the briny ocean. Submerged in another tank is a flowering Phalaenopsis, or moth orchid. Also impossible. This species ordinarily wilts and dies underwater within hours, and the specimen in the tank has been immersed for months.

What makes these two exhibits possible is water containing oxygen nanobubbles (less than 200 nanometers in diameter – 1/500th that of a human hair). The bubbles were created using technology developed by Takahashi at the Institute for Environmental Management Technology at the National Institute of Advanced Industrial Science and Technology (AIST).

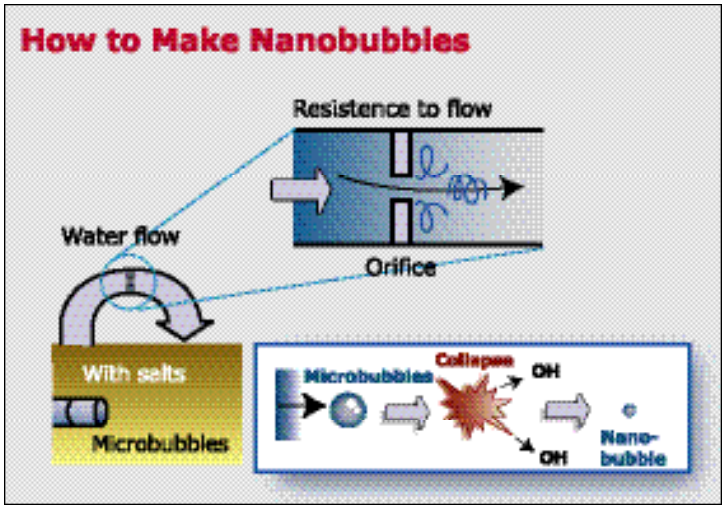
Takahashi, in collaboration with a small company called REO Laboratory Co. and its chief scientist, Kaneo Chiba, has been studying ultrafine bubbles for five years. He has discovered intriguing properties, which could mean exciting applications.

Ordinary gas bubbles expand as they rise, and last a few seconds at the most. Microbubbles (which are at least an order of magnitude larger than nanobubbles), on the other hand, last a few minutes, shrink as they rise and collapse before reaching the surface. Nanobubbles are more stable. They don't rise in liquid, and they last for months.

To produce microbubbles, Takahashi uses a proprietary technique that involves forcing ordinary bubbles in slightly salted water through an orifice, then subjecting them to turbulence. He recently also succeeded in producing the world's first man-made nanobubbles. He will not reveal how he did it, except to say that he made them by compressing microbubbles, and that the process involves "physical stimulation leading to violent adiabatic collapse." He has made two types – oxygen and ozone.

The bubbles have remarkable effects on living things other than fish and flowers. Researchers have fed oxygen-nanobubble water to cows and chickens, and discovered that a variety of health problems – such as intestinal parasites, bacterial infections and general lethargy – cleared up without apparent side effects. Human studies are to proceed once safety has been verified.

In Miyagi prefecture, oyster processor Shizukuishi Suisan is using ozone nanobubbles to clean oysters of norovirus, which releases a toxin that makes them discolored, foul-tasting and poisonous. Soaking in nanobubble water for a day renders the



COURTESY MASATOSHI TAKAHASHI

Takahashi is secretive about the details of nanobubble formation.

oysters entirely free of both the virus and the dark discoloration. The technique may also be applicable to suppressing legionella bacteria and carp herpes virus.

The technology is also being used in food preservation. Shiraken Kamaboko-ten K.K. is producing chemical-free kamaboko (boiled fish paste) treated with ozone nanobubbles. The product will not spoil for several months, about the same as that treated with chemical preservatives. Major food companies have expressed interest.

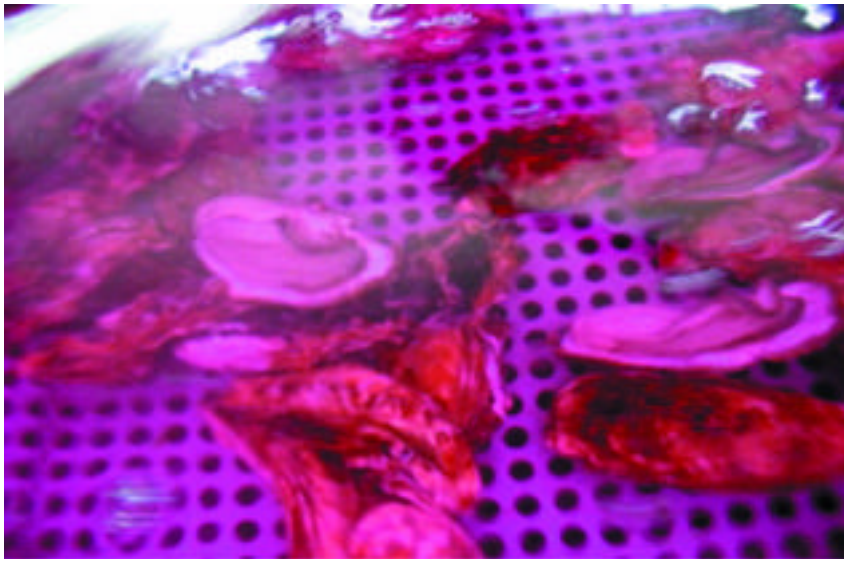
Then there are microbubbles in the bath, cleansing without soap and leaving the skin soft and warm. Takahashi bought a microbubble generator from a Yokohama company, Shigen Kaihatsu Co., for his bathtub. "My wife loves microbubble baths," he says.

Takahashi believes there may be two main characteristics making nanobubbles affect living organisms the way they do. One is their small size, which allows greater amounts of gas to be migrated into and dissolved in a given volume of liquid, and thus to living tissue. The other is that the bubble surfaces may react with the surrounding liquid and change its chemical composition. The mechanism is not yet fully understood, but the smaller the bubble, the more dramatic the reaction.

In addition, as microbubbles collapse, they release free-radical oxygen ions, which are effective in neutralizing a variety of toxins.

Takahashi's primary interest is in eventually using microbubbles to clean up polluted lakes, rivers and ocean inlets. He has already demonstrated their water-cleansing ability, and several sewage-treatment plants use microbubble equipment to clean and detoxify wastewater. He wants to scale the technique up to be able to clean entire bodies of water and restore them to health.

Takahashi has applied for a number of patents, both in Japan and internationally, on technologies related to nanobubbles. He also plans to experimentally tease out precise details of how microbubbles and nanobubbles affect living things. If he can find the time, that is. He has been inundated with inquiries.



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Oysters soak in cleansing liquid made pink by traces of magnesium from the salt component of ozone-nanobubble water.

Robert Cameron is a freelance writer based in Tokyo. The *ACCJ Journal* welcomes suggestions for this column, which focuses on commercialization of scientific and technological advances.