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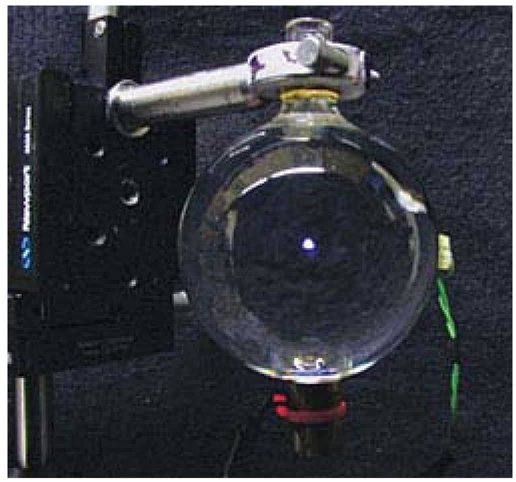
SONOLUMINESCENCE

Bubble Inferno

Acoustic cavitation is shown to yield a plasma, temperatures above 15,000 K

RON DAGANI

Scientists have known for years that the gas inside a collapsing bubble can get so hot that it emits visible light, but they've only been able to theorize and guess at the temperatures involved. Now, chemists at the University of Illinois, Urbana-Champaign, have determined that the gas can get hotter than 15,000 K--roughly three times the temperature at the sun's surface--and that the gas is ionized (a plasma) (*Nature* **2005,** 434, 52).



TINY BUBBLE **A solitary imploding bubble of xenon glows in the center of this flask filled with 85% sulfuric acid.**

DAVID J. FLANNIGAN AND KENNETH S. SUSLICK

This is the first time that anyone has obtained strong experimental evidence for a plasma during acoustic cavitation, says chemistry professor Kenneth S. Suslick, who led the research.

In acoustic cavitation, a liquid is blasted with ultrasound, causing tiny gas bubbles to form, grow, and then collapse. Suslick and graduate student David J. Flannigan were studying single-bubble sonoluminescence (SBSL), in which a solitary bubble repeatedly expands and implodes, emitting flashes of light. The emission spectra from this process typically are featureless and reveal little about what is happening inside the bubble.

By using xenon- or argon-filled bubbles in concentrated sulfuric acid, Flannigan and Suslick were able to trigger SBSL several thousand times more intense than has ever been obtained with water. Even more strikingly, the spectra contained well-resolved spectral lines from atomic and molecular species. From the relative intensity of these lines, the researchers measured the temperature.

The chemists also observed excited states from both argon atoms and O_2^+ that they say cannot arise thermally. "We therefore conclude," they write, "that these emitting species must originate from collisions with high-energy electrons, ions, or particles from a hot plasma core."

In 2002, another lab reported highly controversial evidence that acoustic cavitation in deuterated acetone induces deuterium-deuterium fusion (C&EN, March 11, 2002, page 11). "Our results involve such a different set of experimental parameters that they can neither confirm nor deny" that earlier claim of fusion, Suslick tells C&EN. Although a plasma must exist for fusion to occur, there must also be neutron emission, and "we have not yet detected neutrons," he points out. Suslick is collaborating with another group to study SBSL in deuterated sulfuric acid.

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