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Suslick with sonochemistry apparatus

Sonoluminescence seen in nonaqueous liquids

Chemists at the University of Illinois, Urbana-Champaign, have obtained the first sonoluminescence spectra from hydrocarbon and halocarbon liquids. According to assistant professor Kenneth S. Suslick and graduate student Edward B. Flint, the spectra show unambiguously that the luminescence results from excited-state molecules created during acoustic cavitation [*Nature*, **330**, 553 (1987)].

It's generally agreed, Suslick observes, that sonochemistry results from acoustic cavitation: the creation, growth, and implosive collapse of bubbles in ultrasonically irradiated liquids. However, much sonochemistry is still poorly understood. For example, sonoluminescence in aqueous solutions has been attributed variously to at least three possible origins: black body emission, electric discharge, and chemiluminescence from radical recombination.

In contrast, the sonoluminescence spectrum of dodecane, for example, clearly emanates from excited state C_2 species, and specifically from the vibrational transitions known as Swan band chemiluminescence. The C_2 species are probably created by the recombination of radicals and atoms generated by the high temperatures and pressures of cavitation. Sonoluminescence spectra from mesitylene, 4-heptanone, *n*-butylcyanide, and tetrachloroethylene are qualitatively similar but less intense than that of dodecane.

Swan band chemiluminescence from hydrocarbons is seen in many conditions, including flames, shock tubes, plasmas, and low-pressure discharges. Thus, its appearance under ultrasonic irradiation isn't so surprising. The pressures and temperatures achieved during acoustic cavitation are similar—although on a microscopic scale—to those reached in shock tubes and plasmas. The effective temperature of the microscopic "hot spots" can exceed 5000 °C. Therefore, Suslick and Flint say, their findings show that ultrasound is a powerful chemical initiator and that significant sonochemistry can take place even without reactive solutes.

Indeed, sonochemistry has become a highly competitive research area both in the U.S. and abroad, with a number of potential industrial applications, Suslick says. For example, he has found that ultrasonic irradiation of nickel powder increases its activity as a hydrogenation catalyst by a factor of more than 10^5.

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