When alternative energy sources are mentioned, the image of bubbles rarely comes to mind. Yet two closely related phenomena, sonoluminescence (SL) and laser-induced luminescence (LICL), may shift the spotlight onto bubbles and their potential use in fusion, a promising energy source requiring the union of two nuclei, which in turn requires millions of Kelvin to occur. In SL, an acoustic field forces a bubble to oscillate in sync with the field and in doing so, the bubble emits light. In LICL, it is a laser beam that induces the growth and collapse of a bubble, upon which light is emitted as well. Compared to SL, LICL yields greater light intensity and allows for aspherical bubble collapse, which may prove useful in understanding the nature of cavitation luminescence (1).

The remarkable ability of LICL to focus energy into a tiny volume on the micrometer scale (2) makes it a pleasantly unexpected candidate for fusion techniques. Yet the mechanism of light emission in LICL is not very well understood. One explanation is based on Bremsstrahlung radiation, which is given off by accelerating charged particles. When the laser beam is focused at the center of a solution, the electromagnetic field of the beam ionizes constituents of the solution, forming a plasma. The plasma expands rapidly in the form of a bubble, cools, and subsequently collapses (3). During this collapse, compression ionizes the gas in the bubble, and the resulting free electrons accelerate and emit Bremsstrahlung radiation (2).

Scientists have successfully achieved LICL in a variety of solutions, including pressurized water (2) and even cryogenic solutions such as liquid nitrogen and liquid argon (3). Experiments have demonstrated that the duration of light emission is proportional to the size of the bubble, thus providing a convenient way to gauge the bubbles. Upon increasing the pressure within the pressurized water solution to 10 bars, scientists have measured the light emission from LICL and fit the resulting blackbody spectrum to a whopping temperature of 9400 K (2).

Of course, 9400 K (~9700 degrees Celsius) may seem scorching to a person, but that temperature is nowhere near the millions of Kelvin required for fusion. Furthermore, much work remains to be done in understanding the precise bubble dynamics and mechanism of light emission before trying to engineer a bubble fusion plant. Nonetheless, these experiments can be modified in myriad ways that may enhance the force of bubble collapse. For instance, scientists could experiment with more volatile solutions to make the collapse of the bubble even more violent. An even more drastic change would be to use multiple lasers firing slightly asynchronously to induce collapsing concentric bubbles, thus making the phenomena even more forceful. In fact, scientists have already fused the techniques of LICL and SL, using both a laser pulse and a sound field to enhance the dynamics (4).

In this sense, the versatility and energy concentration power of LICL make it a promising choice for fusion energy.

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References