Estimation of bubble fusion requirements during high-pressure, high-temperature cavitation

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Taleyarkhan's group at Oak Ridge National Laboratory (Tennessee, USA) have claimed to have found evidence of nuclear fusion in a beaker filled with an organic solvent subjected to ultrasonic irradiation [1,2]. More recently, Toriyabe et al. [3] investigated the possibility of fusion reactions occurring during ultrasonic cavitation (UC) in a liquid Li target irradiated with a deuteron (d) beam. Although no meaningful bubble fusion events were detected, extremely large enhancements of $d + d$ reactions were occasionally observed. The bubbles produced by UC, a technique commonly employed in sonochemistry, are typically several micrometers in size, and their collapse can generate microjets with temperatures of several thousand degrees Celsius. In contrast, bubbles produced by water jet (or liquid jet) cavitation methods, such as floating cavitation, are several hundred micrometers in size, and their collapse produces microjets with high pressures of approximately 1.0 GPa.

For many years, fusion reactions have been used to raise the temperature of plasmas to investigate several aspects of this state of matter, including the external energy required to increase the temperature of a plasma, the conditions of a plasma at its critical point, and deuterium–tritium (D–T) reactions. It has been found that, for nuclear fusion to occur, it is necessary for the original nuclei to collide at a speed of over 1.0×10^3 km/s. Thus, the nuclei must experience a pressure of 1.0×10^{11} atm and a temperature of 1.0×10^8 °C.

In the present study, a new cavitation method termed multifunction cavitation (MFC) [4-7], which combines the characteristics of both UC and water jet cavitation, was applied to the study of bubble fusion. This method involves irradiation with ultrasonic waves to achieve low-velocity floating cavitation. The cavitation velocity and the pressure and temperature inside a bubble in deuterated acetone when employing MFC were estimated theoretically and compared to the values required for fusion.

References

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