Original Article
ISSN (Online): 2456-8651

International Journal of Engineering Science Technologies
March-April 2023 7(2), 50–54

CAVITATION FUSION BY ENERGY-INTENSIVE MULTIFUNCTION CAVITATION IN A STRONG MAGNETIC FIELD WITH LASER LIGHT EXCITATION

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Received 15 March 2023
Accepted 9 April 2023
Published 24 April 2023

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DOI 10.29121/IJOEST.v7.i2.2023.492

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ABSTRACT

This paper introduces an experimental apparatus capable of producing cavitation fusion based on laser-assisted high-magnetic-field energy-intensive multifunction cavitation. Combining water jet, ultrasonic and magnetic field energy sources has been shown to increase the luminescence intensity in this system such that the threshold required for deuterium-tritium fusion can be exceeded. The incorporation of a laser provides a further improvement in emission intensity based on an increase in the internal temperature of bubbles. Multiphoton excitation induced by the laser irradiation raises the pressure generated during collisions between bubbles. Consequently, the probability of achieving cavitation fusion is greatly enhanced.

Keywords: Cavitation Fusion, Multifunction Cavitation, Laser Light Excitation

1. INTRODUCTION

To date, various methods of cold fusion have been researched and reported. In particular, ultrasonic cavitation experiments using tritium and deuterated acetone in conjunction with the monitoring of neutron outputs were performed by Taleyarkhan et al. (2002). However, other researchers were unable to replicate the results of this prior experimentation. Our own group has examined the feasibility of bubble nuclear fusion on an experimental and theoretical basis by superimposing magnetic field energy on a water jet Yoshimura et al. (2022a), Yoshimura et al. (2022b). This previous research demonstrated the generation of ultra-high-temperature, ultra-high-pressure cavitation producing the required fusion temperature of 1.0×10^8 K Yoshimura et al. (2021a), Yoshimura et al. (2018a), Yoshimura et al. (2018b), Yoshimura (2020). The author's group has also developed a laser assisted magnetic field energy intensive multifunction cavitation (LMEI-MFC) apparatus intended for surface modification of various materials Yoshimura et al. (2023).

The present work reports an apparatus very similar to the previous LMEI-MFC fusion instrumentation except for the addition of a vacuum apparatus for the purpose of degassing. This system is capable of performing surface modification using pure water or tap water. The nozzle diameter in this LMEI-MFC fusion apparatus is 0.1 mm, although a large-scale device having a nozzle diameter of 0.8 mm and a flow rate of 7 L/min has also been constructed. High-temperature, high-pressure processing using this technique has been shown to impart various characteristics to material surfaces in addition to increased strength Yoshimura et al. (2021b), Yoshimura et al. (2021c), Yoshimura et al. (2021d), Yoshimura et al. (2021e), Ijiri et al. (2022a), Ijiri et al. (2022b), Ijiri et al. (2021a), Ijiri et al. (2021b). A larger WJ nozzle diameter generates a larger cavitation diameter in the water jet, even at a high flow rate. Because deuterated acetone is expensive, this device is also designed to use the lowest flow rate possible. A smaller cavitation diameter will decrease the impact pressure of the microjet during bubble collapse but this pressure can be supplemented by promoting the collision of charged bubbles based on the Lorentz force supplied by a magnetic field or by laser-excited multiphoton ionization. As such, multi-bubble cavitation fusion utilizing interactions among bubbles could possibly be achieved in heavy acetone as an alternative to single-bubble fusion.

2. MATERIALS AND METHODS

Figure 1 presents a diagram of the cavitation fusion apparatus developed in this research. During the operation of this apparatus, heavy acetone is injected at a high pressure of 40 MPa. This heavy acetone cavitation jet is also exposed to ultrasonic irradiation. Bubbles inside the jet undergo isothermal expansion at low sound pressures but experience rapid adiabatic compression at high sound pressures. The repetition of this process of expansion and contraction generates ultra-high-temperature, high-pressure cavitation. The liquid inside these bubbles consequently vaporizes and thermally decomposes such that free deuterium and oxygen atoms and ions are generated. Although this process is performed in a vacuum, some nitrogen and argon from the ambient air are also included from the liquid wall. Despite the high ionization energy of argon, some atoms may be ionized as a consequence of the extreme concentration of energy in this system. In the case that a number of powerful neodymium magnets are placed around the reaction vessel such that a high magnetic field is applied to the jet, the charged bubbles experience a Lorentz force and collide with one another at significant velocities. In addition, in the case that laser light at a wavelength of 400 or 450 nm is incident on the cavitation jet, multiphoton ionization in the interiors of charged bubbles is promoted. The synergistic effect obtained from the rapid contraction of the bubbles due to adiabatic compression and the high-speed collisions between bubbles provides a state in which the pressure and temperature required for nuclear fusion are exceeded. Hence, collisions between deuterium (D) atoms are able to generate helium (He) atoms, neutrons (n), tritium (T) and protons. Furthermore, when D and

T atoms collide, a D-T reaction occurs according to the equation: D + T → 4He + n (14 MeV). The neutrons generated in this manner are detected by a neutron counter installed at the same position as the photon counter that measures the intensity of light emission from bubbles in the standard LMEI-MFC apparatus. The neutron particle beam is capable of passing through relatively dense materials such as iron but, if the neutron beam stays in the member, γ rays can be generated and so precautions must be in place to shield these rays. Therefore, the entire device is covered in high-density polyethylene containing diboron trioxide (B_2O_3), which has a high neutron shielding effect. Regulations require the total effective radiation dose to be 1 mSv or less per week. However, the eventual use of this system as a practical source of energy would require the kinetic energy of the neutrons being emitted to be converted into thermal energy.

Figure 1

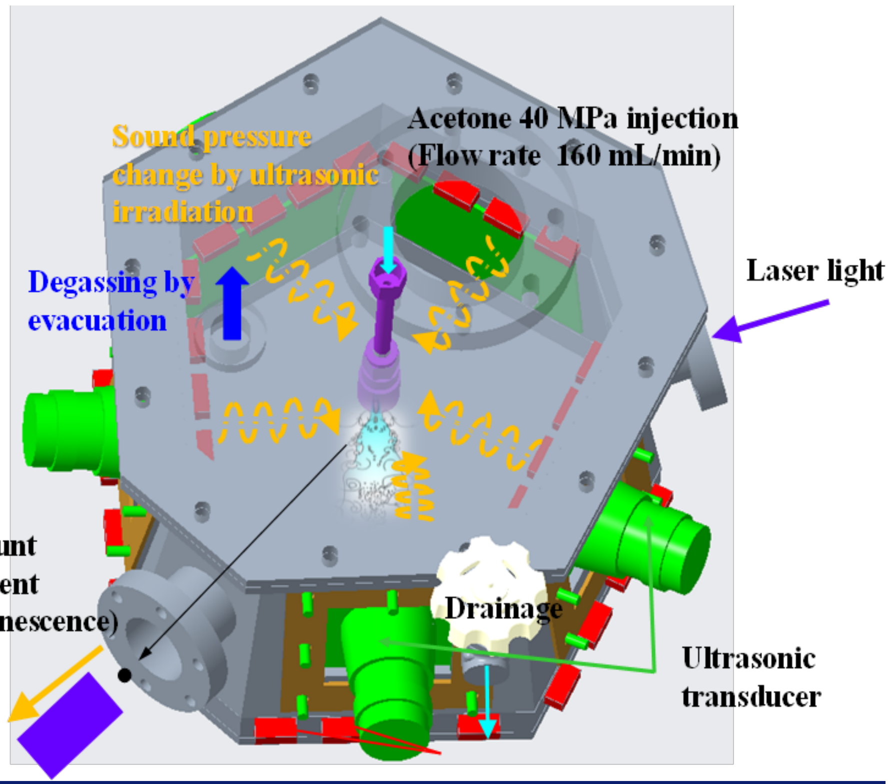

Figure 1 The laser-assisted MEI-MFC cavitation fusion apparatus.

In prior work by Taleyarkhan et al., acetone or heavy acetone was irradiated with neutrons and the amount of neutrons generated was increased compared with the output without neutron irradiation Taleyarkhan et al. (2002), Seife (2002). However, it is unclear to what extent factors such as the reflection of the original neutron beam were involved. In contrast, in the case of the present LMEI-MFC system, a continuous flow of a liquid jet without neutron irradiation provides cavitation. It may also be possible to use a mixture of acetone and deuterated acetone to study neutron generation purely from multi-bubbles in this system, so as to decrease the expense associated with the deuterated solvent.

Although an experimental approach was not possible in this study, the use of a combination of water jet, ultrasonic and magnetic field energy sources in conjunction with laser light has been shown to greatly increase the luminescence intensity obtained from this apparatus Yoshimura et al. (2023). In addition, multiphoton ionization is induced by the laser irradiation and this effect is expected to increase the pressure associated with collisions between bubbles. As a consequence, the total energy that could theoretically be obtained may exceed the threshold required for the D-T fusion reaction. Experimental verification of this possibility is urgently required.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

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