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New Method of Liquid Atomization Based on Pulse Laser Ablation of Liquid Surface

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Abstract

We propose a new method of liquid atomization by pulse laser ablation. When a pulse laser is incident from the water onto the air, the liquid jet occurred on the water surface and atomization proceeds at the tip of liquid jet. It is shown that the produced liquid jet has a very complicated structure, and the duration of the phenomenon is about several tens of μs. In order to observe the liquid jet process, the high-resolution and high-speed imaging of the phenomenon is necessary. In this study, we succeeded in imaging the details of the phenomenon by introducing the combination of a pulse laser shadowgraphy with a high-resolution film.

In this study, we observed liquid jet formation process and investigated the dependence of parameters such as laser energy, beam pattern, and laser fluence (J/cm^2) at the liquid surface. The liquid jet is formed by driving liquid surface by ablation-induced plasma plume. Many slender liquid ligaments are seen extending from water surface like milk crown. Only a part of the phenomena characteristics can find some resemblance to crowning phenomena, and others not. In the liquid jet at an early delay time from the ablation, atomization is seen at the tip of the ligaments. It is also shown that an air shock wave precedes the ligaments. Jet tips are moving at supersonic velocity but decelerated very rapidly. After several tens of μs from laser ablation, the jet direction at the water surface gradually approaches to almost vertical to the surface and the jet collapses afterward. In addition, observation showed that the behavior of the liquid jet and atomization at the tip depends on liquid material.

Key words: Laser ablation, liquid jet, atomization, crowning, laser shadowgraphy

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