Mid-infrared light emission with laser ablation

Shuntaro Tani[1,*], Yohei Kobayashi[1]

[1] The Institute for Solid State Physics, The University of Tokyo, Kashiwa-no-ha 5-1-5, Chiba, Japan
*Corresponding author email: stani@issp.u-tokyo.ac.jp

Laser ablation serves as both a rich non-equilibrium physics playground and a tool for precision micro-machining. Monitoring methods for laser processing dynamics are broadly categorized into active and passive probes. Active methods, like pump-probe spectroscopy and optical coherent tomography, involve an additional laser for monitoring. Passive methods detect light or ionic emissions post-ablation. While light emission spectroscopy covers a wide spectrum from terahertz to x-rays, each probing different ablation aspects, mid-infrared monitoring remains underexplored. This study focuses on observing mid-infrared emissions in the 3-5 μm range using a high-speed camera after laser ablation, targeting blackbody radiation from cooled plasma.

Figure 1 depicts the spatial distribution of mid-infrared emissions from laser ablation plasma following single-shot laser irradiation. A pronounced fluence-dependent variation is evident. Notably, high-fluence regimes exhibit spark-like fragmentary emissions. Through time-gate and spatial analyses, the mid-infrared emissions associated with ablation have been differentiated into fast and slow components.

Figure 2 displays the combined intensity of both components, plotted against pulse duration for various excitation pulse energies. A consistent increase in emitted pulse energy is observed, correlating with both pulse duration and energy. A systematic comparison between emission intensities of both fast and slow components and ablated volume per pulse was conducted, revealing that the mid-infrared region is effective for monitoring volumetric removal rates.

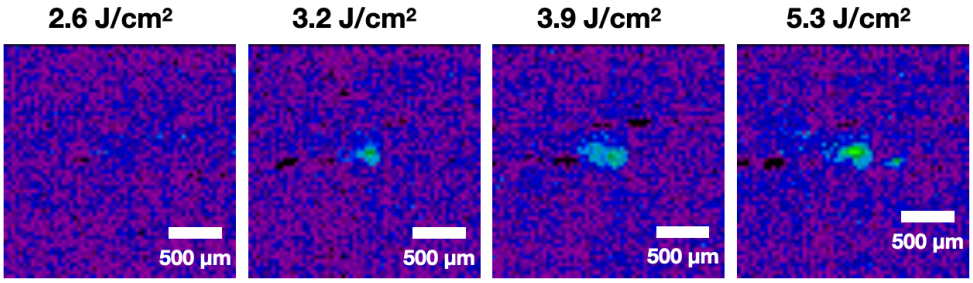

Fig. 1 Spatial profile of mid-infrared emission for various excitation fluences.

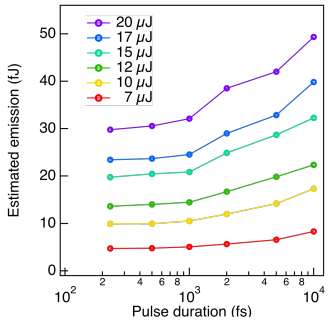

Fig. 2 Net light emission with laser ablation in the range of 3-5 μm as a function of excitation pulse duration.

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