

Laser-induced-fluorescence measurement of thermal conductivity in warm dense matter generated by pulsed-power discharge

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Thermal conductivity in warm dense matter is one of the interests for thermonuclear fusion scenarios. Alternative inertial confinement fusion, which is a fast ignition with applied magnetic field [1], has been considered to improve the coupling efficiency. The target behavior of the fast ignition with applied magnetic field depends on the anisotropic thermal conductivity. The magnetic confinement fusion (MCF) [2] Up to now, the heat load on the divertor in previous MCF systems has been unreached parameter. Thus, to predict properties of the divertor under these heat loads, several experiments have been performed using several methods[3-6]. To predict the performance of the tungsten divertor in MCF, we should analyze not only metallurgical properties but also thermophysical properties of ablated tungsten.

To clarify these topics, we should understand the physical properties of warm dense matter (WDM). WDM physics is applied when the density ranges from $10^{-3} \rho_s$ (ρ_s is the solid density of matter) to $10 \rho_s$ and the temperature ranges from 0.1 eV to 10 eV. WDM offers the possibility for scientific exploration of the properties of plasma at high densities and moderate temperatures. In this study, we experimentally demonstrated a laser-induced-fluorescence measurement of thermal conductivity in WDM generated by pulsed-power discharge.

Figure 1 shows the typical image of the laser-induced-fluorescence measurement of thermal conductivity in WDM generated by pulsed-power discharge [7-8]. The ruby capillary as a tamper can be sustained the high pressure up to 3 GPa, which is enough to conserve the dense plasma without hydrodynamic behavior. The capillary is also phosphor to measure the pressure and its temperature. The physical properties of ruby are well-known.

To evaluate the specific heat of dense plasma, the pulsed-power discharge technique is compatible due to the correctly evaluation of the input energy and the temperature for dense plasma. From the time-resolved spectroscopic measurements of both the sample and the ruby

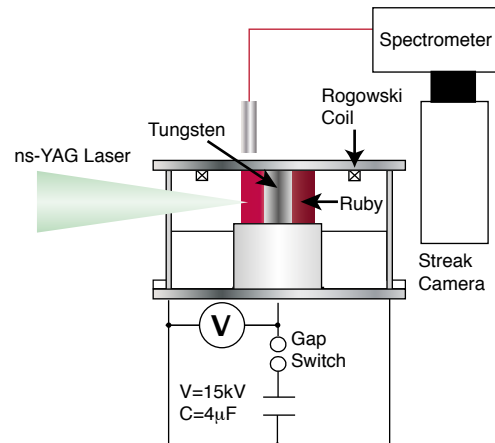


Fig. 1 Typical image of the laser-induced-fluorescence measurement of thermal conductivity in WDM generated by pulsed-power discharge

fluorescence driven by ns-YAG laser, we can determine the temperature of dense plasma and that of ruby capillary. The time-evolution of input power for the dense tungsten plasma is directly estimated by the input voltage and the current. Therefore, the specific heat of the dense tungsten plasma as a function of that temperature can decide the time-evolution of input power. The time-evolutions of ruby and plasma temperatures were observed. From these temperatures, we can determine the thermal conductivity of warm dense matter by using laser-induced-fluorescence measurement.

References

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