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Study of solid to plasma transition of Warm Dense Matter generated by ultrashort laser pulses

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Materials under high intensity femtosecond laser irradiation yield extreme material conditions called warm dense matter (WDM) with thermal energy comparable with the Fermi energy and the ion-ion coupling parameter exceeding unity. The WDM state exists in a variety of processes ranging from laser micromachining to inertial confinement fusion experiments. The WDM exists as transient states including as nonthermal WDM in the first few hundred femtoseconds when the electron thermalization is important and as two temperature WDM with initially high electron temperature and relatively low ion temperature. The initial electron temperatures depend on its heat capacity. Subsequently, the electron temperature would fall and the ion temperature would increase subsequently the WDM transits into the plasma state (typically called laser ablation). The rates of ion temperature increase depend on the electron-ion coupling. We have used pump-probe techniques to study WDM produced by irradiating few ten's of nanometers thick free-standing metal foils with high intensity femtosecond laser pulses. In this talk, I will present the results of electron heat capacity and electron-ion coupling factor of the heated foils extracted from the measured optical conductivities. present the studies of dissemble and structural change processes of the heated foils using optical Frequency Domain Interferometry and Electron Diffraction techniques respectively. Finally, I will present the comparison of the experimental onset laser ablation times with predictions from several molecular dynamic (MD) simulations using different electron heat capacity and electron-ion factor values to illustrated these two parameters play important role in modeling ultrafast laser ablation using MD models.

Keyword-1

Warm Dense Matter

Keyword-2

Laser Plasma

Keyword-3

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