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Quasi-DC Terahertz Electrical Conductivity Measurements of Dense Aluminum Plasma GEORGE RODRIGUEZ, BALAKISHORE YELLAMPALLE, JAMES GLOWNIA, ANTOINETTE TAYLOR, KI-YONG KIM, Los Alamos National Laboratory — We report on our investigation of electrical transport in ultrashort laser-heated aluminum. By measuring the complex electrical conductivity at terahertz (THz = 10^{12} Hz) frequencies, we explore the dependence of electrical transport across the material phase transition from the cold solid to the dense plasma state. Using optical-pump, terahertz-probe spectroscopy, we measure the phase shifts and absorption of terahertz probe pulses that are reflected from the warm (0.1∼3 eV) dense plasma. To characterize the THz field, we develop and use a single-shot, high temporal-resolution THz diagnostic capable of measuring free-space electromagnetic pulse fields in time and space. In contrast to the previous measurements of conductivities at optical frequencies, our THz non-contact probe method can directly measure quasi-DC electrical conductivities, providing insight into the transport nature of warm dense matter without dependence on conductivity models for extrapolation. Full hydrodynamic laser-foil calculations and THz Helmholtz wave equation calculations of the THz probe field show that deep penetration across the plasma gradient and into the dense solid is achieved with the THz probe. The technique demonstrates a new promising ultrafast time-resolved diagnostic capability for extracting conductivity transport.

Ki-Yong Kim
Los Alamos National Laboratory

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