Temporal evolution of the temperature of solid-density gold and diamond samples heated by a laser-driven ion beam

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Energetic laser-driven ions (~ 10% of the speed of light) can heat small solid-density samples (~ 10 microns) above 10,000 K before a significant hydrodynamic expansion occurs [1-3]. It is important to heat the sample uniformly to analyze the physical properties of the heated sample. Recent studies showed that energetic laser-driven ions with some energy spread can heat small solid-density samples uniformly [1-3]. The uniform heating of the sample is accomplished as the result of the balance among the energy losses of the ions with different kinetic energies [3,4]. Although heating with an energetic laser-driven ion beam is completed within a nanosecond and is often considered sufficiently fast, it is not instantaneous.

Here, we offer a computational analysis of the temporal evolution of the temperature of solid-density gold and diamond samples heated by a quasi-monoenergetic aluminum ion beam [3], using the available stopping power data and the SESAME equation-of-state tables.

We find that the temperature distribution is initially very uniform, which becomes less uniform during the heating process. Then, the temperature uniformity gradually improves, and a good temperature uniformity is obtained toward the end of the heating process.

References
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Figure 1. A laser-driven aluminum ion beam can heat small solid-density gold samples up to sixty-thousands of kelvin [1-3]

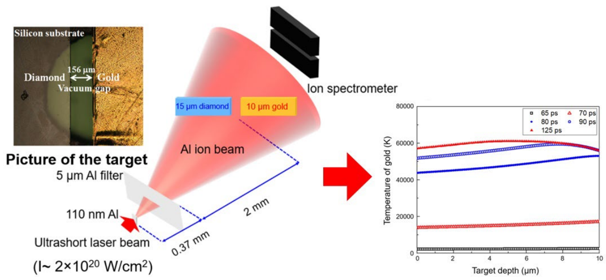
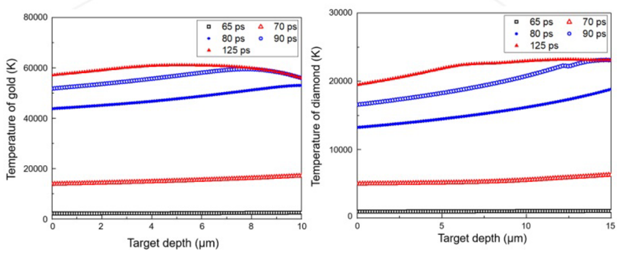


Figure 2. We calculate the temporal evolution of the expected temperatures for solid gold and diamond samples heated by a energetic laser-driven Al ion beam [3].



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