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Realizing isotopic temperature profiling by using laser-driven neutron source

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Non-contact thermometry, including phase-contrast imaging thermography, is one of the key technologies for modern science and industry. However, it is challenging to instantaneously measure the temperature of a specific element inside an object. As a possible solution, we propose Neutron Resonance Absorption (NRA) analysis using a Laser-driven Neutron Source (LDNS). Here, fast neutrons generated from the LDNS are decelerated down to a few eV in energy and pass through a sample consisting of tantalum (Ta) and silver (Ag) plates as a simplified model of a composite object. We measured NRA signals distinctive for the Ta and Ag. We demonstrate that the temporal structure of the NRA signal for Ta is broadened by a Doppler effect when the plate of Ta is heated. We measured the NRA signal as a function of the temperature and found that the Doppler width increases according to the free gas model by Bethe. It should be emphasized that the NRA measurement was performed by a single pulse of neutrons, the temporal duration of which is in an order of 100 ns at the sample. In other words, the NRA signal allow us to obtain the temperature during the 100 ns. This fact indicates that our method enables element (isotope)-sensitive and non-destructive thermometry to monitor the instantaneous temperature rise in dynamical processes.

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