

SEMINARIUM RENTGENOWSKIE

Laboratorium SL-1 zaprasza na seminarium, które odbędzie się w dniu 31.10.2023 r. w godz. 10:30-12:00, Sala D

Tytuł seminarium:

Observation of picosecond melting of Pd films using X-ray free electron laser pulses

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Afiliacja Prelegenta: Wydział Fizyki, Politechnika Warszawska

Abstrakt

Due to its extremely short timescale, the non-equilibrium melting of metals is exceptionally difficult to probe experimentally. The knowledge of melting mechanisms is thus, to a large extent, based on the results of theoretical predictions and computer modeling. This talk reports on the ultrafast melting of thin polycrystalline Pd films studied by an optical laser pump – X-ray free-electron laser probe technique and two-temperature model molecular dynamics simulations. By acquiring the X-ray diffraction snapshots with sub-picosecond resolution, we capture the sample's atomic structure during its transition from the crystalline to the liquid state. Bridging the timescales of the experiment and the simulation allows us to formulate a realistic microscopic picture of the melting transition. We demonstrate that the melting process gradually accelerates with the increasing density of deposited energy. The molecular dynamics simulations reveal that the transition mechanism progressively varies from heterogeneous, initiated inside the material at structurally disordered grain boundaries, to homogenous, proceeding catastrophically in the crystal volume on a picosecond timescale comparable to that of electron-phonon coupling. Even though the shortest observed melting time in Pd is an order of magnitude smaller than in gold, the melting mechanism of both metals remains similar. We conclude that the rate of laser-induced melting of thin polycrystalline Pd film is, as in gold, limited by the timescale of lattice heating. Our work highlights the role of crystal defects, either pre-existing as grain boundaries or generated on heating, in the melting transition.

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