Melting dynamics of radiation damaged tungsten studied with ultrafast electron diffraction

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Here we report the results of using ultrafast electron diffraction technique to study the melting dynamics of radiation damaged tungsten excited by femtosecond optical pulses. The radiation damaged tungsten were made by bombarding 30nm thick tungsten films with 500 keV Cu ions. The radiation damaged samples together with the pristine ones were excited by 130fs (FWHM), 400nm laser pulses, and the subsequent heated system was probed with 3.2MeV, 350fs (FWHM) electrons. As compared to pristine tungsten targets, the pre-damaged ones experience a larger and faster decay in Debye-Waller factor of Bragg scattering, suggesting a phonon softening effect caused by the ion bombardment. The measurement also shows that pre-damaged W transitions into complete liquid phase for conditions where pristine W stays partially molten. The results can be employed to test the theories of lattice dynamics and electron-ion coupling of tungsten under extreme matter conditions, as well as to understand the radiation induced damage effect to the tungsten-shielding wall in magnetic fusion reactors.