Contribution ID: **3650** Type: **not specified**

P5.2005 Equilibration of electron-hole plasma during the formation of warm dense matter

Friday, 12 July 2019 14:00 (2 hours)

See the full abstract here http://ocs.ciemat.es/EPS2019ABS/pdf/P5.2005.pdf

The recent advent of the XFEL allowed us to follow ultrafast electron dynamics in the HED matter. We used femtosecond pulses from the PAL-XFEL to measure the ultrafast changes in the X-ray absorption of Cu nanofoil excited by intense laser pulses. Upon exposure to laser irradiation, significant portions of both the s/p and d electrons are excited, and the strongly perturbed copper evolves into warm dense matter with temperatures of a few eV. In this contribution, we present the results of measurements of the X-ray absorption spectra below the copper L_3 edge with 150 fs resolutions. The data visualize the creation and annihilation of holes in the highly excited Cu d band. Comparison of the experiment with the predicted absorption based on the two-temperature-model enabled the initial nonequilibrium durations to be determined at a stage at which the TTM is non-applicable. This investigation allows us to quantify the lifetimes and the decay speed of d holes in warm dense copper, which are a few orders longer and slower, respectively, than known values. It raises an issue of the fast thermalization concept and the widely used two-temperature model to describe the nascent stage of intensively photoinduced material responses.

It has been supported by the National Research Foundation (NRF2016R1A2B4009631) of Korea.

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Presenter: CHO, B. (EPS 2019)

Session Classification: Poster P5