Relativistic interaction of nanostructured solids with short and long wavelength ultrashort laser pulses

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For the first time, we present an experimental study comparing the interaction of intense ultrashort laser pulses at 400 nm or 4 µm with nanostructured solids. The experiments were carried with pulses delivered from the frequency doubled output of a multi-TW Ti: Sapphire laser system or a high-power femtosecond mid-IR OP-CPA laser system operating at 4 µm wavelength. Arrays of nanowires consisting of low- (Si) and mid-Z (Zn) targets enable volumetric heating mechanism and generating ultra-dense and hot plasmas. For the same value of the relativistic parameter $a_0 \propto \sqrt{I\lambda^2}$, the conversion efficiency (determined as the ratio of the energy of the X-ray emission in 4π to the energy of the laser pulse) for the generation of the K-shell radiation from neutral target material is more than one order of magnitude higher for the long wavelength laser driver than for the short wavelength one. In contrast, the efficiency of characteristic line emission from high charge ionic states is higher for the short wavelength driver (Fig.1) which can be explained by the wavelength dependence of the direct field ionization of the target material. The measured high resolution spectra of the characteristic line emission and continuous hard X-ray spectra have been compared with results of PIC simulations. These results provide insight into the parameters of the generated plasmas, suggesting solid density plasma in experiments with both short and long wavelength relativistic laser pulses. More details will be than presented at the conference.

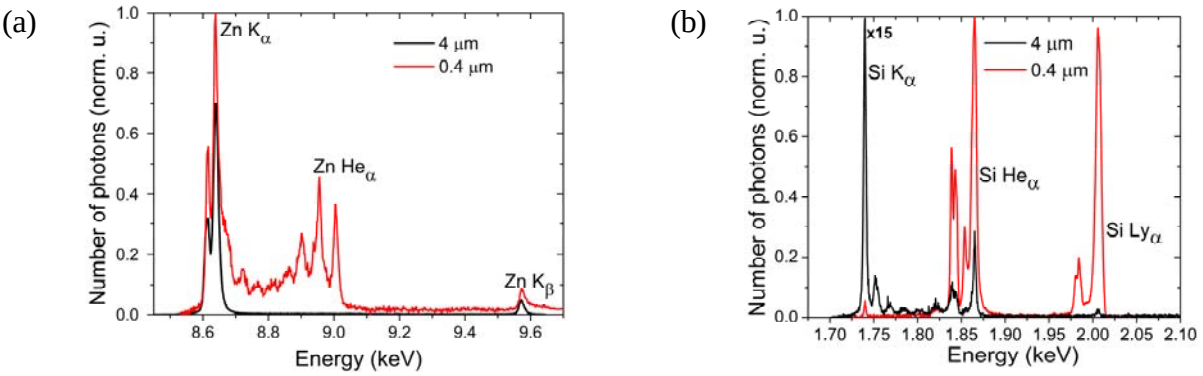

Figure 1: K-shell emission spectra from ZnO NW (a) and Si NW (b) targets generated by ultrashort relativistic laser pulses with long (red) and short (black) wavelengths.