Clusterized surface transformation under intense heating generated by laser-accelerated proton irradiation

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Today, there are multi-hundred-TW table-top short-pulse laser systems that can generate on-target intensities of around 10^{19} to 10^{21} W/cm² and can routinely produce proton beams in the multi-MeV range[1]. The short bunch duration and the very intense and localized heating properties of these beams are perfectly suited for studies in warm dense matter or material science. Here, we use laser-accelerated protons to analyze the effect of an intense and short (ns-scale) energy deposition process occurring on solid metal surfaces and studying its evolution on a ns and nm scale. We show that thermal shocks generate a uniformly distributed clustered heating on a surface[2], with the dimensions of the clusters depending on the irradiation dose and on the duration of the thermal shock. When quickly cooling down, the clusters can produce large nanostructured surfaces[3], [4]. Controlling the dose allows us to obtain nanostructured surfaces with a low dispersion in particle dimension, a high density of particles and a polycrystalline morphology.

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