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Tunable Metallic Nanocrystal Generation using Laser-Driven Proton Irradiation

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Laser-driven proton acceleration, as produced during the interaction of a high-intensity (I>1x10^18 W/cm^2), short pulse (<1 ps) laser with a solid target, is a prosperous field of endeavor for manifold applications in different domains, including astrophysics, biomedicine and materials science. These emerging applications benefit from the unique features of the laser-accelerated particles such as short duration, intense flux and energy versatility, which allow obtaining unprecedented temperature and pressure conditions. In this paper we show that laser-driven protons are perfectly suited for producing, in a single sub-ns laser shot, gold nanocrystals with tunable diameter ranging from tens to hundreds of nm and very high precision. Our method relies on the intense and very quick proton energy deposition, which induces in a bulk material an explosive boiling and produces nanocrystals that aggregate in a plasma plume composed by atoms detached from the proton-irradiated surface. The properties of the obtained particles depend on the deposited proton energy and on the duration of the thermodynamical process. Suitably controlling the irradiated dose allows fabricating nanocrystals of a specific size with low polydispersity that can easily be isolated in order to obtain a monodisperse nanocrystal solution. Molecular Dynamics simulations confirm our experimental results.

Working group

Laser-driven ion acceleration

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