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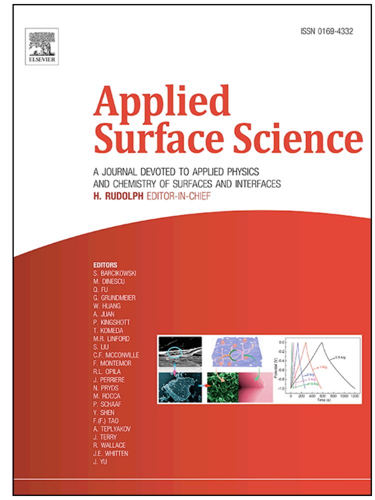

Full Length Article

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Ablation target cooling by maximizing the nanoparticle productivity in laser synthesis of colloids

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Abstract

Even if ultrashort laser pulses are used during the laser synthesis of colloids, a significant amount of laser energy is converted into thermal energy, which results in heating the ablation target and the colloid. To date, little attention has been paid to these heating effects in the literature. This study was focused on measurements of the process temperature during the high-power, ultrashort-pulsed laser ablation of a nickel target in a continuous water flow setup. Time-resolved monitoring of the temperature of the ablation target and of the colloid indicated that there was an initial rapid uptake of thermal energy followed by a thermally-stable state in which there was very little additional heating. Shifting the focal plane from behind the target onto its surface and further into the fluid provided insight concerning the different mechanisms of heat generation, dissipation, and transfer in the laser synthesis of colloids. It even was possible to distinguish the fluence effects and the colloid re-irradiation effects. New possibilities of process control were identified by correlating the productivity of laser ablation at different focal plane shifts with the measured thermal data. Counterintuitively, the temperature of the target was minimized via ablation cooling when the productivity of the process was maximized.

Keywords: Laser ablation; Picosecond; Temperature; Nanoparticles; Nickel; Productivity