Metallic film deposition by femtosecond laser ablation in air at atmospheric pressure

Achu Purushothaman[1,*], Jijil JJ Nivas[1,2], Gabriella Maria De Luca[1,2], and Salvatore Amoruso[1,2]

[1] Dipartimento di Fisica Ettore Pancini, Università degli Studi di Napoli Federico II, Complesso Universitario di Monte S. Angelo, Via Cintia, Napoli I-80126, Italy
[2] CNR-SPIN UOS Napoli, Complesso Universitario di Monte S. Angelo, Via Cintia, Napoli I-80126, Italy
[*]Corresponding author email: achupurushothaman477@gmail.com

The deposition of thin films by pulsed laser ablation is a well-established method for the elaboration of nanostructures, thanks to the possibility of using diverse laser sources tuning different processing parameters (e.g. laser fluence, target-to-substrate distance, ambient gas, etc.). The use of femtosecond (fs) laser pulses in vacuum results in an ablation plume with a predominance of nanoparticles that can be collected on a substrate to form a nanoparticle-assembled thin film. The process is generally carried out in a vacuum or in an ambient gas at low pressure. In vacuum, the atomic and nanoparticle plumes formed by the laser ablation of the target material expand freely, whereas a rather complex interaction occurs when the ablated species expand in a background gas: as the gas pressure increases, the expansion of the ablation plumes is progressively braked and eventually halted over a length of the order of a centimeter for pressures of tens of mbar. At atmospheric pressure, the plume length can be further reduced to few millimeters from the target surface.

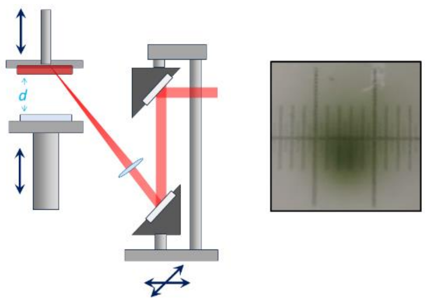

Figure: Sketch of the experimental setup (left) and photo of a deposit on a glass substrate.

The possibility of deposition by laser ablation at atmospheric pressure is of interest to explore the prospect of avoiding a complex vacuum chamber system and identify its potential for certain applications. Here we will report our preliminary experimental results on the deposition of Cu in air at atmospheric pressure by using 1030 nm, ≈180 fs laser pulses at high repetition rate (≥ 1 kHz) on substrates held at room temperature or heated to several hundred degree Celsius. The figure shows a sketch of the experimental setup (left) and a photo of a deposit on a glass substrate at room temperature that extends over several mm in size. The deposition was carried out at a distance d≈10 mm using laser pulses at a laser fluence of ≈ 5 J/cm^2 at a repetition rate of 1 kHz, scanning the laser beam on the target surface.