Spot Size Control in Shaping Film Thickness Distribution: Nanosecond vs. Femtosecond Laser Ablation

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The geometry of the ablating spot is the principal parameter in determining the evolution of the plasma plume [1-2] and thereby the spatial thickness variation of the growing PLD film [3-4]. In the critical domain of spot sizes spanning from 0.01 to several mm^2, the spherical plasma plume transforms into a strongly forward-peaked, one-dimensional material flow. While this tendency remains apparently consistent independently of the energy profile across the ablating spot and pulse duration, its extent varies significantly: the range of exponents describing the angular distributions of the film thickness in terms of the $f(\Theta)=\cos^n\Theta$ formalism spans wide, exceeding even 50.

In order to elucidate the contribution of the characteristics of the spot and the pulse duration to the film properties, in particular to the thickness distribution, copper films are deposited at fixed pulse energy, tuning the size of the homogeneously irradiated ablating spots within the critical domain, while ablating with nanosecond vs. 600 fs pulses at 248 nm, keeping all other process parameters identical. Different aspects of the results are discussed by analysing the peculiarities of the relevant ablation mechanisms, considering possible applications in thin film technology, and sharing our thoughts on the terminology used, as well.

References:

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