PARTICULATE DYNAMICS IN LASER ABLATION PLASMAS

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Particles in laser ablation processes may play both the positive (for fabrication of nanostructured materials) and the negative (in thin film deposition, for example) role. The understanding of particles formation and growth is important for both these aspects since it might aid in synthesis of nanosized particles with controlled properties as well as in avoiding of particulate contamination of growing thin films.

In the present paper the dynamics of metal and carbon particles formed by laser ablation under different environments (gas and liquid media) were studied. The ablation plume particles collected on the substrates were examined by optical and electron microscopy methods.

The experimental setup included two Nd-YAG (1064nm, 10ns, 1-4 J/cm^2) lasers operating at the fundamental or second harmonics. The laser pulses were employed for ablation both singly and together with appropriate temporal delays between pulses. The laser beams were focused on the surface of the samples (Cu, Ta, graphite) placed in the chamber with helium atmosphere at various pressures or in the cell with water. The power densities at the target were in the range of 10^8-10^9 W/cm^2.

Spectroscopic characterization of the ablated plume was performed by the time resolved emission spectroscopy. The plasma emission spectra (300-700nm) were recorded and compared for different ablation regimes. The major species including neutral, ionized and some molecular species within the plume were identified.

The spatial and temporal scales for particles in laser ablation plumes were determined by time resolved laser light scattering. The typical velocities of carbon particles in 600 Torr helium atmosphere was estimated from time-of-flight profiles to be $4\cdot10^3$ cm$\cdot$s^{-1}. For characterization of the particle size the optical absorption spectra of deposited structures were measured and calculated by using Mie theory. The optical measurements were found to correlate with the results of analysis of the fabricated powders by electron microscopy method.

The results obtained may serve as a basis for more detailed experimental studies on the nanoparticles formation by the laser ablation in various environments.