Understanding plasma multi-structuring and molecular formation in laser produced plasmas on Ag in various gases

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Angular and time-resolved measurements were performed by implementing the Langmuir probe technique and space-and time-resolved optical emission spectroscopy for the investigations of transient plasmas generated by ns-laser ablation of Ag in various background gases. The aim of this work was to understand the inner mechanism of laser produced plasma dynamics by controlling the ionic energy distribution during the deposition process. The experiments were performed on laser plasmas generated on Ag targets at a constant irradiation condition (λ = 266 nm, ν =10 Hz and Fluence = 3.8 J/cm^2) in various expansion regimes (p = 10^{-6} – 10 Pa of Ar, N_2 and O_2). The electrical investigations were mainly focused on recording the saturation ionic and electronic currents at various angles (in a 45^o range) with respect to the main expansion axis at 4 cm from the target in the vicinity of the substrate holder. For each investigated pressure a time-resolved analysis was performed on the main expansion axis which allowed the determination of a wide series of plasma parameters and their spatial evolution. The novelty of the study comes from recording also the floating potential in all conditions. This approach allowed us to showcase a multiple structuring of the Ag laser produced plasmas and to reconstruct the ions energy distribution. The structuring is seen in the ionic part of the collected current and confirmed by the fast electrons distribution which matched the ionic one. Each structure characterizes an ionization state of the Ag ions, results confirmed by performing optical emission spectroscopy along the main expansion axis and discussed in the framework of multiple double layer formation during plasma expansion. Complementary, optical emission spectroscopy allowed the spatial and temporal monitoring of visible and U-V emission of the plasma. The contribution of each gas influences the emission in a particular manner corelated with the data from the electrical measurements. In each of the investigated conditions thin films were deposited and we could corelated the films properties with the ones of the plasma. A special case is for Ag in O_2 where we show the scenario for AgO molecule formation and it's impact onto the plasma energy.