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A model explaining low and high ablation regimes in a carbon arc[1]

ALEXANDER KHRABRY, Lawrence Livermore Natl Lab, IGOR KAGANOVICH, ANDREI KHODAK, VLADISLAV VEKSELMAN, TIANYUAN HUANG, Princeton Plasma Physics Lab — Graphite ablation in a presence of inert background gas is widely used in different methods for the synthesis of carbon nanotubes, including electric arcs and laser/solar ablation systems. The ablation rate is an important characteristic of the synthesis process. It is known from multiple arc experiments that there are two distinguishable ablation regimes, so-called "low ablation" and "high ablation" regimes in which the ablation rate behaves qualitatively differently with variation of the arc parameters [1], [2]. We developed a theoretical model that explains low and high ablation regimes by taking into account the presence of a background gas and its effects on the ablation rate. We derive analytical relations for these regimes and verify them by comparing them with full numerical solutions in a wide range of arc parameters. We comprehensively validate the model by comparing to multiple experimental data on the ablation rate in carbon arcs, where various arc parameters were varied. Good qualitative and quantitative agreement between full numerical solutions, analytical solutions, and experimental data was obtained. [1] V. Vekselman et. al., Plasma Sources Sci. T. 26, 065019 (2017). [2] J. Ng and Y. Raitses, J. Appl. Phys. 117, 063303 (2015)

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