

Absorption spectroscopy measurements of atomic and molecular carbon population densities in an expanding thermal arc plasma

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ABSORPTION SPECTROSCOPY MEASUREMENTS OF ATOMIC AND MOLECULAR CARBON POPULATION DENSITIES IN AN EXPANDING THERMAL ARC PLASMA

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Absolute population densities of argon and atomic and molecular carbon are determined using the method of reabsorption in the expanding thermal arc plasma during the deposition of a-C:H coatings. The reactor conditions under which the experiments have been performed were the following: background pressure 20 - 200 Pa, argon flow rate 58 - 116 scc/s, arc current 45 A, arc voltage 70 - 80 V, hydrocarbons (CH_4 or C_2H_2) with a flow rate of 3 - 6 scc/s were injected either into the nozzle of the arc, or directly into the vessel.

Depending on the gas mixture argon - methane/acetylene, and the hydrocarbon injection (downstream or in the nozzle), the stationary positive or negative absorption between the quantum states of $\text{Ar}(3p^54p \rightarrow 3p^54s)(\lambda = 696.5 \text{ nm})$, $\text{C}(2p^23s \rightarrow 2p^21s)(\lambda = 247.9 \text{ nm})$ and $\text{C}_2(d^3\Pi_g, v' = 0 \rightarrow a^3\Pi_u, v'' = 0)$ (band head at $\lambda = 516.5 \text{ nm}$) are determined. From this absorption the absolute population densities of the radicals in the plasmas are obtained. Depending on the plasma conditions the density of the argon first excited state $\text{Ar}(3p^54s, ^3P_2)$ was $\simeq 10^{16} - 10^{17} \text{ m}^{-3}$, whereas the atomic and molecular carbon densities were of the order of $10^{18} - 10^{19} \text{ m}^{-3}$. Possible implications for the deposition of a-C:H coatings and the role of C_2 in the deposition mechanism are discussed.