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On the effect of Substrate Temperature on a-Si:H deposition using an expanding Thermal Plasma

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Fast (8 nm/s) deposition of amorphous hydrogenated silicon with a mid-gap density of states less than 10^{16} cm^{-3} and an Urbach energy of 50 meV has been achieved using a remote argon/hydrogen plasma. The plasma is generated in a DC thermal arc (0.5 bar, 5 kW) and expands into a low pressure chamber (20 Pa) thus creating a plasma jet with a typical flow velocity of 10^3 m/s. Pure silane is injected into the jet immediately after the nozzle, in a typical flow mixture of $Ar:H_2:SiH_4$=55:10:10 scc/s. As the electron temperature in the jet is low (typ. 0.3 eV), silane radicals are thought to be produced mainly by hydrogen abstraction.

Material quality in terms of refractive index, conductivity, microstructure parameter and optical bandgap was found to increase monotonously with substrate temperature. It will be argued that the observed behavior is consistent with a growth concept suggested by Gallagher, Perrin and Matsuda involving physisorption and hopping, abstraction, growth on dangling bonds and thermal desorption of hydrogen.