FAST DEPOSITION OF AMORPHOUS LAYERS

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In this presentation the fast deposition of amorphous hydrogenated silicon (a-Si:H) and amorphous hydrogenated carbon (a-C:H) using the expanding thermal arc will be reviewed. This experimental set up consists of a cascaded arc, which expands into a low pressure background (0.2-0.4 mbar). The cascaded arc is a flowing subatmospheric wall stabilized plasma (flow range typ. 10-100 scc/s and arc current 25-90 A) and is operated in argon or argon/hydrogen mixtures. In the jet section the monomers are injected, C_2H_2 and SiH_4 for respectively a-C:H and a-Si:H deposition.

In this remote type of plasma the production of the deposition precursors is by means of chemical conversion of the produced ion with the injected monomer to form a molecular ion, e.g. in case of Ar^+ with CH_4

$$Ar^+ + CH_4 \rightarrow CH_4^+ + Ar \qquad (1)$$

after which the molecular dissociatively recombines with an electron

$$CH_4^+ + e \rightarrow CH_2 + H_2 \qquad (2)$$

In case the upstream plasma is generated in an Ar/H_2 mixture an alternative chemical conversion can take place through hydrogen abstraction of the injected monomer, e.g. in case of SiH_4

$$H + SiH_4 \rightarrow SiH_3 + H_2 \qquad (3)$$

So by varying the process parameters as the hydrogen seeding, the flow, the arc current etc. the dominant radical can be tuned.

Using an Ar/C_2H_2 a-C:H layers are deposited under different conditions. Varying the arc current in one series and the monomer flow C_2H_2 in an other series and keeping the other conditions (including substrate temperature) fixed, the growth rate, hydrogen bonding, hardness and refarctive index are determined. When analyzed as function of the growth rate (in the range 10-25 nm/s) the results indicate an increasing quality, i.e. increasing hardness, refractive index etc., of the deposited a-C:H as function of increasing growth rate. The results will be compared with deposition models present in the literature to explain this observation. Results from plasma characterization studies will be used to obtain information on particle and energy fluxes towards the substrate.

$Ar/H_2/SiH_4$ mixtures are used to deposit a-Si:H with the aim to produce solar cell grade intrinsic a-Si:H material at large growth rates (up to 15 nm/s). The layers are analyzed using various techniques. Results of these analysis will be discussed.