A growth model for the fast deposition of a-Si:H

9:20 am **PS2-MoM4 A Growth Model for the Fast Deposition of a-Si:H,** *R.J. Severens*, *J. Bastiaanssen*, *M.C. Sanden*, *D.C. Schram*, Eindhoven University of Technology, The Netherlands

Results on the fast deposition of a-Si:H using an expanding thermal plasma are presented. The substrate temperature was varied from 100 up to 350°C while the plasma conditions were kept constant at I_{arc}=45 A, $Ar/H_2/SiH_4$=55/10/10 scc/s and chamber pressure 0.18 mbar. Hydrogen content [H] was measured using infrared absorption spectrometry, growth rate is determined using in situ ellipsometry. Urbach energy E_u and density of states at midgap DOS using dual beam photoconductivity absorption spectroscopy. Slit experiments are performed to establish the sticking probability of the depositing radical. [H], E_u and DOS decrease with increasing substrate temperature. The values for the best sample deposited at the highest temperature of 350°C are: [H] = 7%, E_u = 48 meV and DOS = $5x10^{15}cm^{-3}$. The growth rate is around 7 nm/s and independent of substrate temperature. The results are explained on the basis of a kinetic growth model. It is assumed that the SiH_3 radical is the dominant radical for growth. SiH_3 is first physisorbed on the hydrogenated a-Si:H growth surface. Growth sites, i.e. dangling bonds, are created either by means of hydrogen abstraction by the surface diffusing physisorbed SiH3 radical to form SiH_4 or by thermal desorption of H_2. The latter process is stronger for higher substrate temperatures. The growth occurs by the chemisorption of the SiH_3 radical on a dangling bond. It is postulated that the DOS is proportional to the density of dangling bonds present on the growth surface. Since thermal desorption is larger for higher substrate temperatures it is essential that the growth rate is large (> 1 nm/s) when the substrate temperature is high (> 300°C). The reason is that the number of dangling bonds on the growth surface otherwise would be high, which would result in a higher DOS. Hydrogen incorporation in this simple model occurs when the SiH_3 is chemisorbed. The chemisorption releases 2.2 eV which is available for the direct desorption of H_2. The latter effect could explain the observed small activation energy for hydrogen incorporation. The model also predicts a growth rate which does not depend on the substrate temperature.