Kinetics of hydrogen interaction with a-Si:H based thin films and structures : In situ ellipsometry investigation

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Abstract

Atomic hydrogen is intimately linked to the growth process of hydrogenated amorphous silicon (a-SiH) by Plasma Enhanced Chemical Vapor Deposition (PECVD) and plays a controversial role in the final optoelectronic properties of a-Si:H based materials and devices. A good way to probe the interaction between hydrogen and a-Si:H is to expose the material to hydrogen plasma and follow in situ the induced changes through the thickness (dH) of the modified layer and its hydrogen excess (fH). Just after their deposition, we have exposed a-Si:H based thin films structures to H2 plasma in a PECVD reactor and studied in situ, by ellipsometry, the kinetics of hydrogen diffusion. To monitor the effects of H2 plasma treatment in the case of a thin film, we have varied both the rf power (5 – 30 W) and the gas pressure (0.5 – 2 Torr). Our results revealed that i) An increase in the rf power linearly enhances fH without affecting dH. ii) Raising the hydrogen pressure leads to an irregular and nonmonotonous evolution of dH with a maximum around 1.5 Torr while DCH remains almost constant. iii) The kinetics of hydrogen diffusion depends on the doping of a-Si:H material. In the case of a-Si:H based homojunctions, the time-evolution of both dH and fH evidences special features which should be attributed to the effects of the electrical field of the junction on the diffusion of charged hydrogen.

Keywords: H2 plasma, a, Si:H, diffusion, etching, ellipsometry

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