EFFECT OF ATOMIC DEUTERIUM ON a-Si:H THIN FILMS

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Hydrogenated amorphous silicon (a-Si:H) and nanocrystalline silicon (nc-Si:H) are cost-effective alternatives to crystalline silicon in photovoltaic and thin film transistors for flat panel displays. Hydrogenated amorphous and nanocrystalline silicon films can be deposited inexpensively at low temperatures and uniformly over large areas using plasma enhanced chemical vapor deposition (PECVD) from SiH4-containing glow discharges. The hydrogen content of the films plays a key role in determining the electrical properties. It is well known that the hydrogen content and the microstructure of the deposited films can be modified by exposure to a hydrogen plasma. However, the interaction of atomic hydrogen with the films is not well understood. More specifically, the mechanism and the energetics of the reactions that occur between the surface and bulk hydrides and atomic hydrogen are not known. Therefore, the goal of this study was to gain insight into the interaction of atomic hydrogen with the deposited films. We have developed an in situ method based on attenuated total internal reflection Fourier transform infrared (ATR-FTIR) spectroscopy to determine the silicon hydride (SiHx, x = 1,2,3) concentration on the surface and in the bulk of the growing film. The films were deposited in an inductively coupled plasma (ICP) reactor from SiH4/Ar feed gas mixture. The films were then exposed to a pulsed deuterium plasma. It is expected that the energetics and mechanism of reactions of deuterium with the film would be very similar to hydrogen. Deuterium exposure helps in observing the removal of hydrogen independent of insertion of deuterium and exchange of hydrogen by deuterium since the SiHx and SiDx stretching modes appear at different wave numbers. Evolution of the SiHx and SiDx stretching modes was observed after each pulse by large number of averaged scans to improve the signal to noise ratio. The data was then used to determine the energetics of surface hydrogen abstraction by atomic deuterium.