Hydrogen kinetics in a-Si:H and a-SiC:H thin films investigated by Real-time ERD

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Thin film silicon technology has been used in photovoltaics for more than 30 years following the first demonstration by Carlson and Wronski of efficient a-Si based devices. Thin layers of hydrogenated amorphous silicon (a-Si:H) and microcrystalline silicon (μc-Si:H) are used as absorbers in single and tandem cells as their respective bandgap of 1.75 eV and 1.1 eV allow them to absorb photons from near-infrared to the visible light. Alloying a-Si:H with carbon increases the bandgap of the resulting a-SiC:H films above 2.0 eV; the wide bandgap of the material renders it suitable for use as a window layer in n-i-p Si based solar cells. Hydrogen (H) plays a beneficial role in both a-Si:H and a-SiC:H by passivating the dangling bonds and thus reducing the defect density. However the kinetics of hydrogen in this films may affect the stability of a-Si and a-SiC:H based devices upon illumination and/or when used in high temperature conditions. This contribution presents the results of hydrogen effusion and diffusion as studied by in situ real-time elastic recoil detection (ERD) on a-Si:H and a-SiC:H films processed by the hot-wire chemical vapour deposition (HWCVD). Ramped anneals from RT to 600 °C were used to study the evolution of the H profile in the layers deposited on c-Si substrates. In optimized a-Si:H films, it is found that the H-diffusion at high temperatures above 500 °C while with a-SiC:H, H-effusion is observed at much lower temperatures. The presented results of kinetic parameters are obtained from a single ramped anneal.

Keywords: Elastic recoil detection; kinetic parameters; dangling bonds