Growth of Boron-doped Epitaxial Silicon by Low Temperature PECVD

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Low temperature (<200°C) plasma-enhanced chemical vapor deposition (PECVD) is investigated as an alternative way to form pn junctions for solar cells fabrication. Compared to standard diffusion, PECVD deposition ensures a lower thermal budget and the formation of a sharper doping profile. We have previously demonstrated the successful growth of thin boron doped epitaxial silicon at 175°C by PECVD[1]. In this study we focus on the activation of the incorporated boron (related to B-H and B-O complexes) and the structural relaxation in the layers when annealed at temperatures above the deposition one. The epitaxial films have been characterized by various experimental techniques including secondary ion mass spectroscopy, high resolution x-ray diffraction and Hall effect, both in their as-grown state and after annealing. Depending on the growth temperature, either B-H and/or B-O complexes are thought to be the causes of the low conductivity in as-grown layers. We have also found that while the conductivity increases with temperature (Fig. 1), past a threshold – which we have estimated to be around 300°C – the layers relax and defects are generated in the epitaxial film, causing an additional decrease of the carriers mobility. Finally, we integrate the doped epitaxial layer into a simple device (Fig. 2) in order to assess its electrical behavior. Dark I-V measurements are performed and the diode characteristics extracted[2]. Such solar cell structures have previously shown promising results[3, 4].

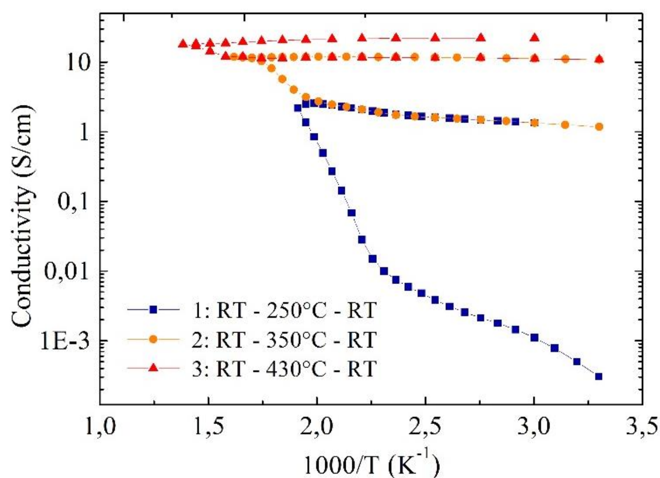

Figure 1. Conductivity as a function of the temperature measured for an epi-Si layer grown on a SOI (silicon on insulator) substrate.

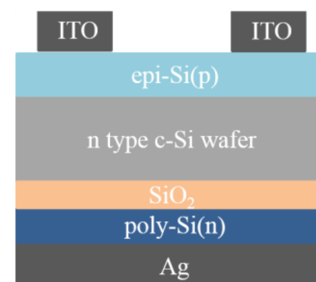

Figure 2. Schematic of the pn junction structure used to evaluate the electrical quality of boron doped epitaxial layers grown by low temperature PECVD.

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