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Defect analysis of amorphous silicon solar cells by Fourier transform photocurrent spectroscopy

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To understand better the degradation mechanisms of amorphous silicon solar cells, it is important to analyse the defects and their evolution during light-soaking in an actual device structure. Fourier transform photocurrent spectroscopy (FTPS) provides interesting insights, as it allows measuring subgap absorption on complete solar cells with a high precision. This allows the determination of different defects at different energy levels in the band-gap. In this study, we analyse the subgap absorption of a-Si:H p-i-n solar cells whose intrinsic absorber layers were deposited at various deposition temperatures. By varying the temperature between 100 and 350°C and keeping the other parameters constant, a series of cells with a large spectrum of defects were obtained. The cells were then progressively light-soaked, while measuring their performance and FTPS spectra at regular intervals (Figure 1).

The variation of cell efficiency with the deposition temperature cannot be explained only with the mid-gap defect density, particularly for high deposition temperatures (Figure 2), but other factors have to be taken into account, e.g. the tail states, band-gap and durability of the p-layer at high temperature. Degrading the cells induces an increase of the Urbach energy and of the defect density, but no change in the defect energy. When comparing the defect density with the cells electrical performances, it appears that the relative increase of the defect density correlates with the efficiency decrease.

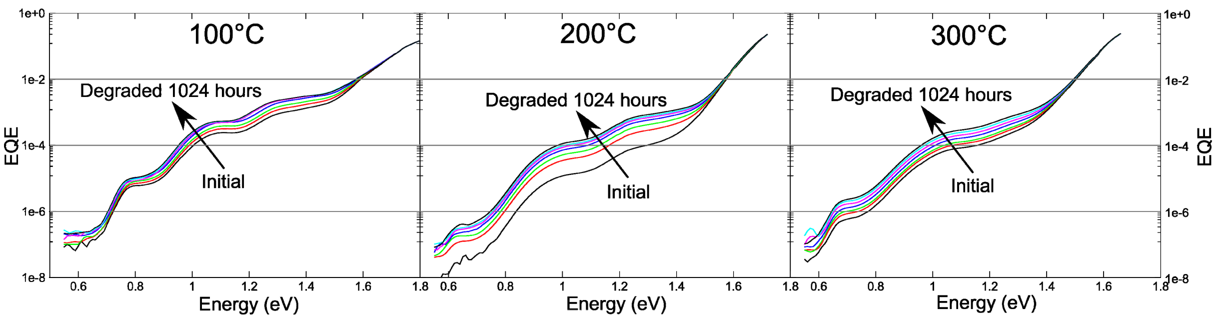

Figure 1: FTPS spectra of cells deposited at 100°C, 200°C and 300°C, for increasing light-soaking times.

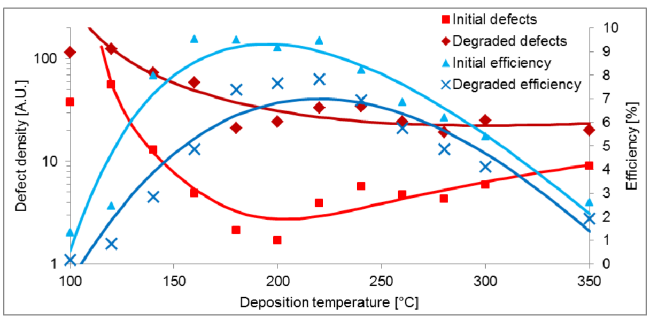

Figure 2: relative defect density and efficiency at the initial and degraded states. The lines are guides to the eye.