Roll-to-Roll APCVD SnO_2:F deposition

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The Helianthos solar cell project intends to develop a roll-to-roll manufacturing process for photo-voltaic modules on foil substrates. The aim of the project is to lower the kWh cost of solar cells, by reducing both module and system integration costs. The device structure contains a transparent fluorine doped tin oxide (SnO_2:F) window layer a thin film silicon absorber and a reflective back contact.

Currently a roll-to-roll pilot line in which continuous 30 cm foil substrates are employed is nearing completion. In this presentation we discuss initial results from the new pilot APCVD process for the deposition of the transparent window

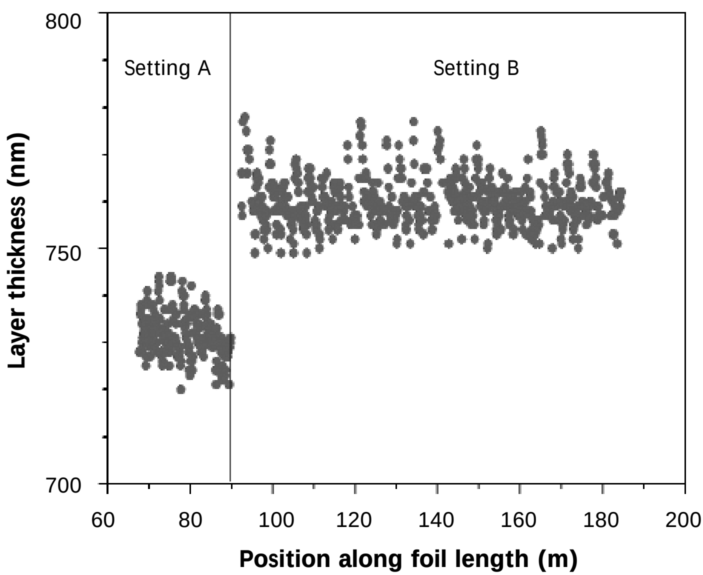

Figure 1

Layer thickness along the foil length

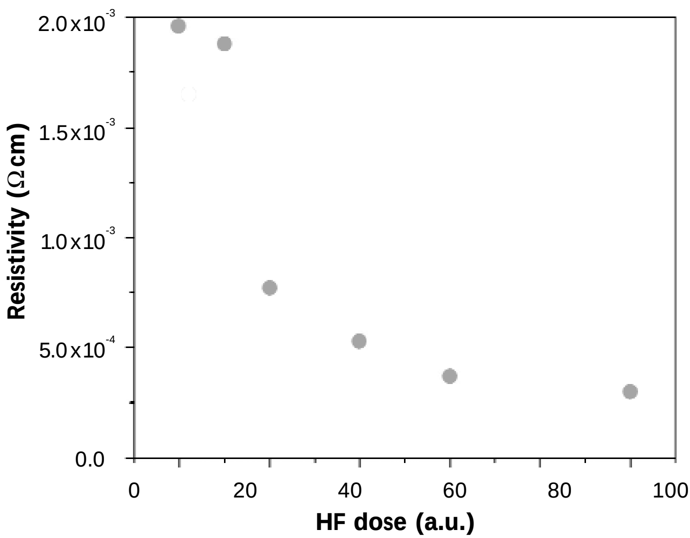

Figure 2
Resistivity as a function of HF dose

layer, in terms of both process characteristics (throughput, homogeneity and stability) and material properties of the deposited transparent conductive films (electrical, optical, surface texture, and of course solar cell performance)

Process stability and control of the APCVD pilot have been the primary points of attention over the past period. We monitor layer thickness on-line and established layer thickness variations of 2 % during depositions longer than 100 meters. Samples were taken out of such rolls and showed no significant variation in sheet resistance and SEM image. The dynamic deposition rate during these depositions was over 300 nm m/min.

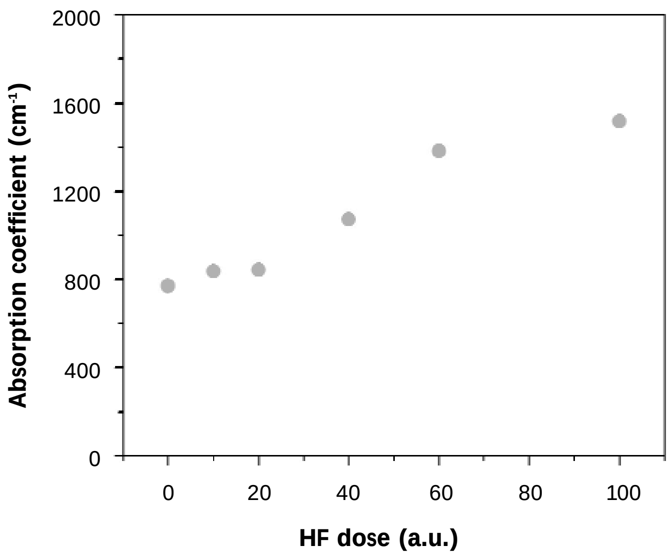

Figure 3
Absorption coefficient as a function of HF dose

Electrical and optical properties were determined for SnO_2:F layers as a function of the dopant (HF) flow. In the figures the thickness-independent values of resistivity and absorption coefficient are given (all layers had a layer thickness around 750 nm). The corresponding sheet resistance values are between 25 and 4 Ω/sq and the effective transmission values between 95 and 89 % (i.e. the part of the light not absorbed in the layer, reflection losses were already corrected for in the dual beam measurement)

The surface texture of the TCO layers is not considered optimal yet *(see fig. 4)*, but good progress in this field is made in the lab machine of TNO within the Helianthos consortium. On pieces of TCO layer cut out of rolls from the pilot, single pin a-Si cells were deposited (in a batch lab PECVD process) with 8.1 % initial active area efficiency. Monolithically series integrated solar cell modules of

8 x 2 cm^2 were also produced on these TCO samples, yielding initial active area efficiency values between 4.5 and 6.5 %.

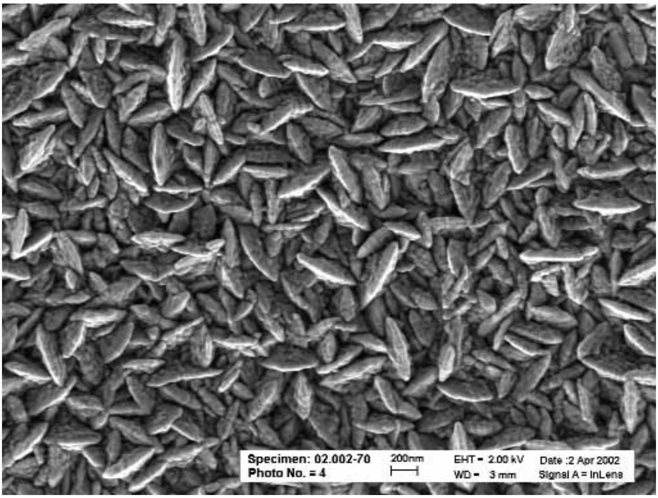

Figure 4

TEM micrograph of TCO surface from pilot line