

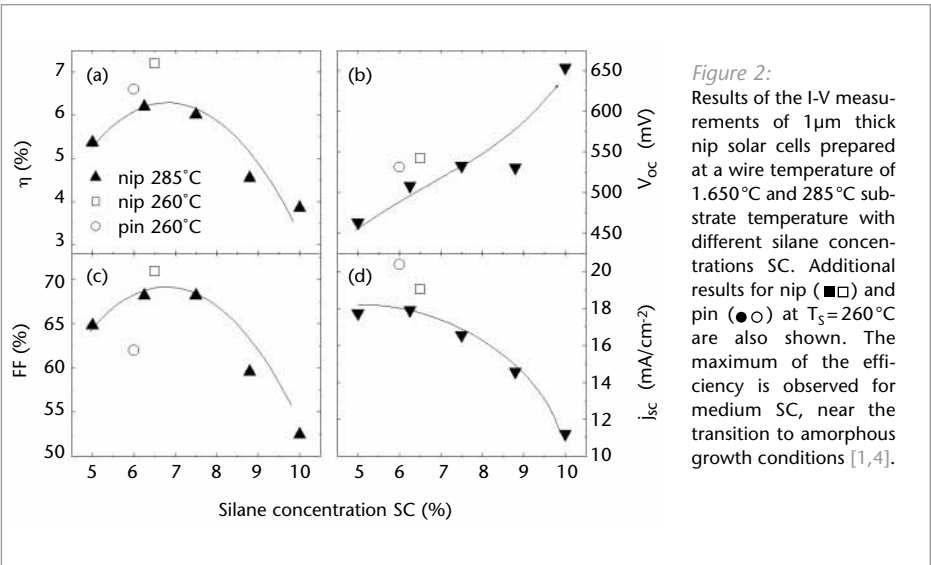
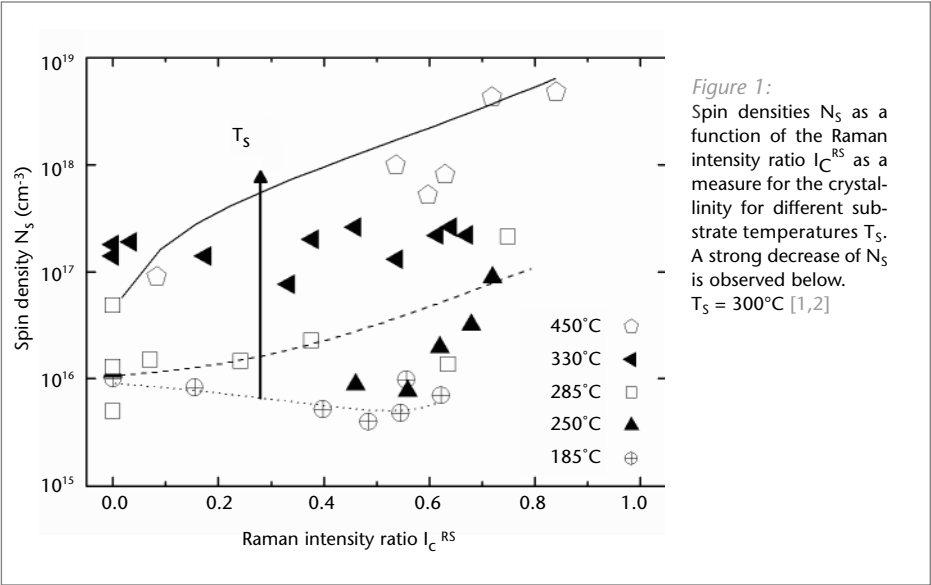
Intrinsic microcrystalline Silicon by hot-wire chemical vapour Deposition for Solar Cell Applications

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Hot-wire chemical vapor deposition was used to prepare microcrystalline silicon ($\mu\text{c-Si:H}$). The deposition at low substrate temperature improves the material quality substantially. Microcrystalline films prepared at a substrate temperature T_s of 285 °C and a filament temperature of 1.650 °C showed very good material properties with a spin density N_S as low as $1 \cdot 10^{16} \text{ cm}^{-3}$ measured by ESR and an oxygen and carbon content of $2 \cdot 10^{18} \text{ cm}^{-3}$ at a deposition rate of 2.5 \AA s^{-1} .

As shown in *Fig. 1*, a further reduction of T_s results in even lower spin densities [1]. This kind of material exhibits a dominant SiH stretching mode at 2.000 cm^{-1} and did not show SiO-modes in the infrared absorption spectra, indicating compact material structure [1,2].

By incorporating this material into microcrystalline silicon solar cells, we achieved an initial efficiency of 7% in substrate-type nip solar cells, and by reducing T_s to 260 °C, the efficiency could be improved to 7.5%. *Fig. 2* shows the solar cell J-V parameters under AM 1.5 illumination as a function of the silane concentration SC. The J-V parameters show the typical behaviour of $\mu\text{c-Si:H}$ solar cells. The efficiency reaches the highest values at SC = 7%, originating from a continuously increasing open circuit voltage, the decreasing short circuit current density with increasing amorphous fraction and the maximum of the fill factor.



However, for superstrate type pin solar cells, this temperature is still too high, as the much lower fill factor indicates. By reducing the substrate temperature further below 200 °C, we obtained microcrystalline solar cells with an initial efficiency of 9.4%. These cells show a extremely high open circuit voltage of up to 600 mV in combination with high fill factors above 70% and high short circuit current densities J_{SC} exceeding 25 mAcm⁻² [1,3].

Literature

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