TCO gratings for a-Si:H and µc-Si:H solar cells

N. Senoussaoui,
M. Krause, J. Müller,
T. Brammer, H. Stiebig,
W. Beyer
FZ-Jülich (IPV)
n.senoussaoui@fz-juelich.de

Amorphous (a-Si:H) and microcrystalline (µc-Si:H) silicon thin film p-i-n diodes require effective light trapping schemes to achieve efficient absorption. Hence, textured transparent conductive oxides (TCO) with a randomly distributed surface morphology are widely employed.
As an alternative approach periodic light coupler gratings of ZnO were prepared by different photolithography, etching and lift-off processes and used as substrates for solar cells with a-Si:H or µc-Si:H absorber layer. The periods and the groove depths were adjusted independently from each other and vary between 1 to 4 µm and 100 to 600 nm *(Fig.1 and 2)*, respectively. The thickness of the i-layer was chosen to 450 nm for the a-Si:H and to 1µm for the µc-Si:H p-i-n diode.

The effect of the grating on light scattering and the opto-electronic properties of the solar cells were investigated. The measured diffraction angles of the rectangular grating show a wavelength dependency in accordance to the grating formula. The angular distribution of the scattered light depends strongly on the grating period and groove depth. However, for the realized solar cells with a-Si:H or µc-Si:H i-layer the short circuit current, I_{sc}, shows no significant influence of the grating period but I_{sc} increases with elevating groove depths. In comparison with cells on smooth substrates for cells with grating the spectral response in the long wavelength region is enhanced.

However, I_{sc} is smaller compared to diodes deposited on substrates with a randomly distributed texture. We will present a detailed study on the optical and optoelectronic

AFM and SEM measurements of ZnO gratings

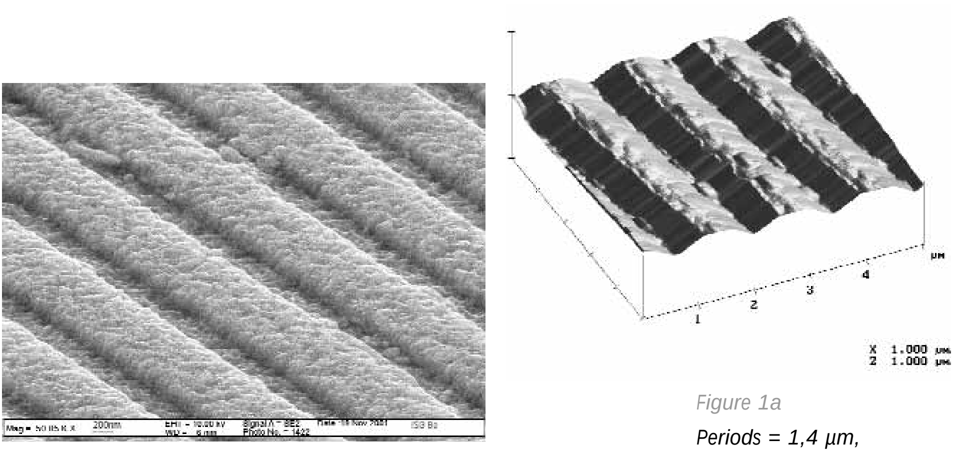


Figure 1a

Periods = 1,4 µm,

Groove = 182 nm

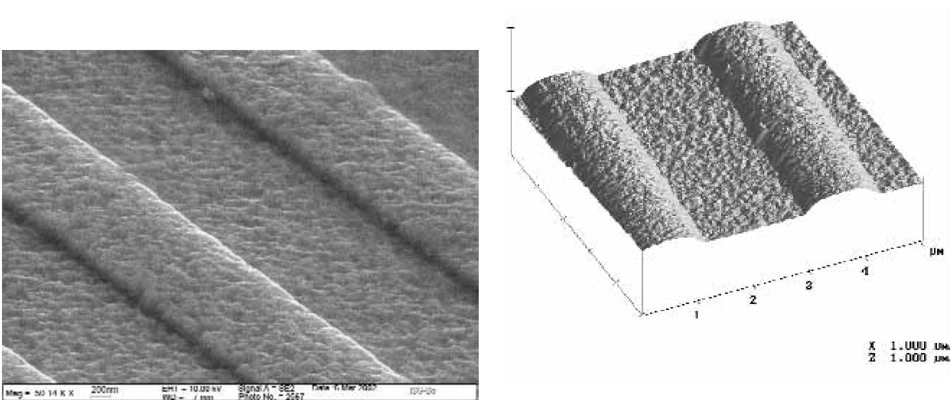


Figure 1b

Periods = 3 µm,

Groove = 190 nm

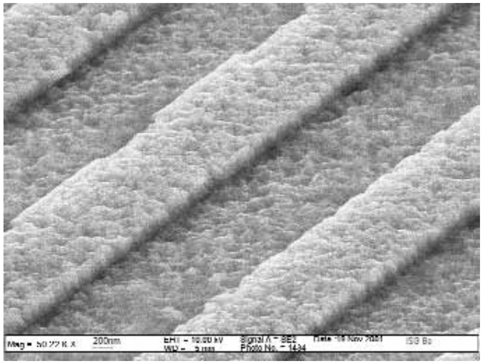
properties of substrates and corresponding solar cells as a function of period and groove depth to evaluate the application of periodic light coupler structures in solar cells.

SEM measurements of 2µm period with different grooves

Figure 2

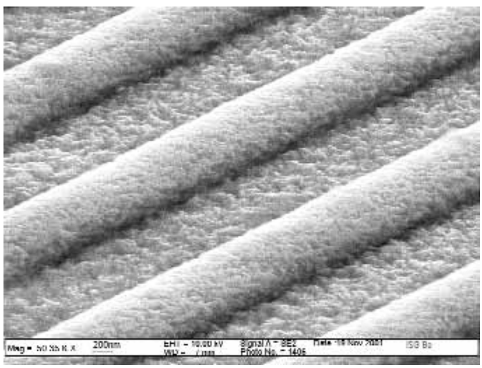
Period = 2µm

Groove = 200 nm



Period = 2µm

Groove = 400 nm



Period = 2µm

Groove = 600 nm