Surface passivation of textured c-Si wafers by low-T PECVD a-Si:H

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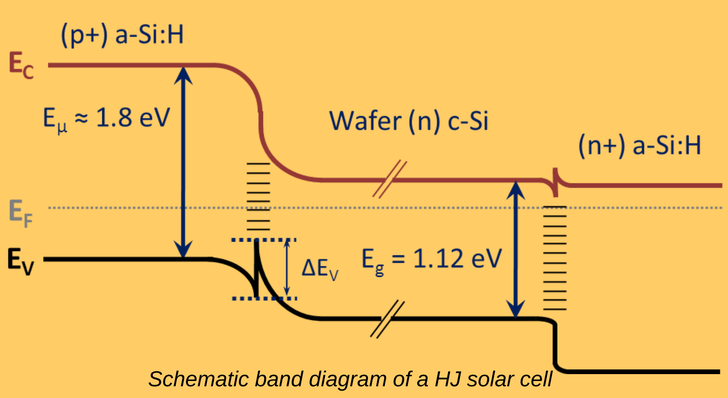
a-Si:H as a passivating layer

Technical characteristics

➔ high Voc (Sanyo 745mV) due to the E_g difference [1]
➔ high efficiency ~24%
➔ outstanding passivation of the wafer surface…

Cost effectiveness

➔ use of thin wafers (<100µm)
➔ low-T PECVD processes,
➔ Si materials…

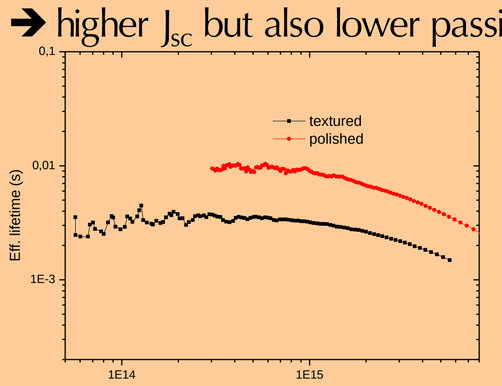


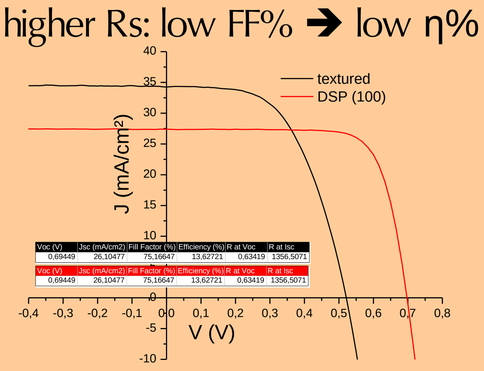
Schematic band diagram of a HJ solar cell

Texturing for a higher J_{sc}

Light-trapping enhances cell performances

➔ chemical texturing (KOH…)
➔ pyramid-shaped landscapes
➔ higher J_{SC} but also lower passivation and higher Rs: low FF% ➔ low η%





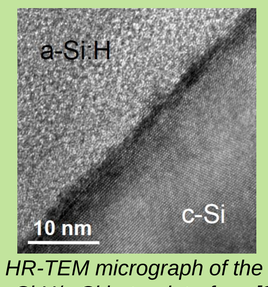
<111> orientation study

Chemical texturing reveals <111> facets of the c-Si crystalline wafer

➔ study of the passivation on <111>-oriented flat c-Si surfaces
➔ better understanding of textured wafer passivation

Detection of epitaxial centers: TEM

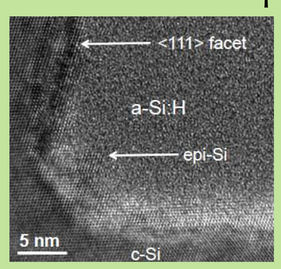
➔ epitaxial centers in the interlayer phase are probably at the origin of high Rs and low FF
➔ need for an a-SiC:H buffer layer to kill epitaxy on <100> c-Si. No such need on <111> surfaces



HR-TEM micrograph of the a-Si:H/c-Si heterointerface [2]

<100> regions after chemical etching

➔ even small <100> regions in pyramid valleys can foster epitaxial centers growth [2]



HR-TEM picture showing epi-Si in a valley [2]

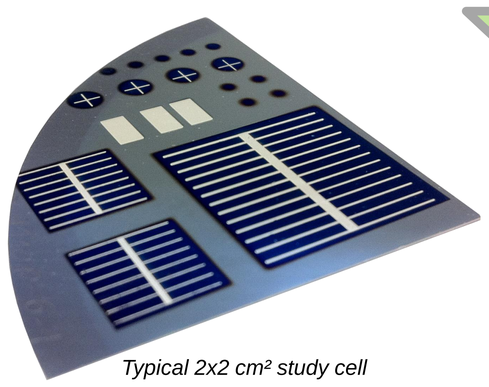
➔ TEM imaging to get a deeper understanding of the role of the a-SiC:H buffer layer in the case of textured substrates

Experimental Work &Prospects

Deposition process

➔ a-Si:H layers are deposited in the ARCAM 13,56 MHz RF PECVD home-made reactor at the PICM lab
➔ processes are being transfered to our new PECVD cluster tool "CLUSTY"

TOTAL new cluster tool "CLUSTY" at the PICM lab



Typical 2x2 cm² study cell

Prospects

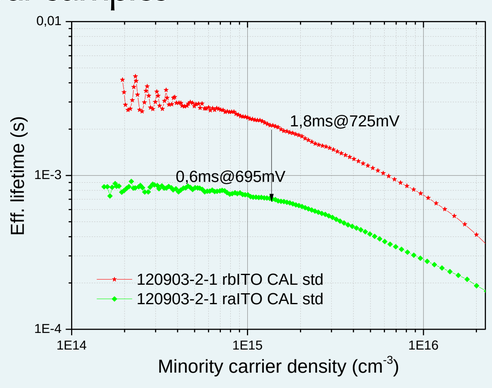
➔ understand <111> deposition chemistry in order to avoid high R_s coming from epi-Si centers
➔ optimize specific recipes for i, n+ and p+ layers on <111> c-Si
➔ transfer recipes on textured wafers

Technical challenges

➔ transfer recipes to new PECVD reactor
➔ (i), (n+) and (p+)a-Si:H
➔ ITO

ITO's unexpected impact

➔ RF-PVD ITO deposition process generates passivation losses up to 76% on our samples



➔ even if these losses can be partially recovered through annealing[3], irreversible structural changes occur[4]
➔ understanding these changes could lead to better layer qualities
➔ higher η%? …

References

[1] S. De Wolff et al., Green, Vol. 2 (2012), pp. 7–24
[2] S. Olibet, PhD thesis, 2008
[3] D. Zhang et al./Energy Procedia 8 (2011) 207-213
[4] B. Demaurex et al., Applied Physics Letters 101, 171604 (2012)

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