Area-Selective Atomic Layer Deposition of In_2O_3 based on the c-Si doping level

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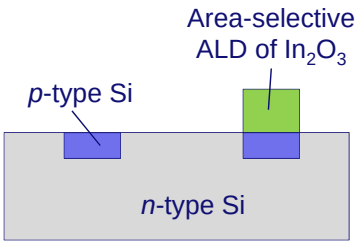
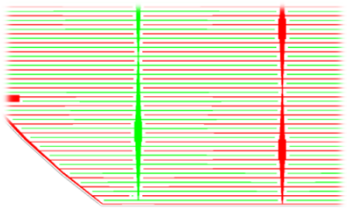
Objective

- Can we obtain area-selective deposition based on the doping level of c-Si?

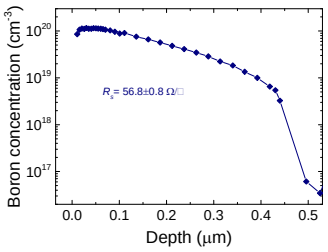
Approach;

- Atomic-layer-deposited (ALD) of In_2O_3 as model system





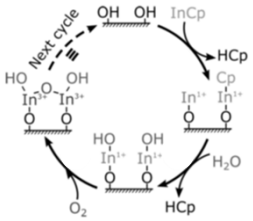
Example: Back-contact solar cell with interdigitated *p*- & *n*-type Si pattern



Boron doping profile

Experimental

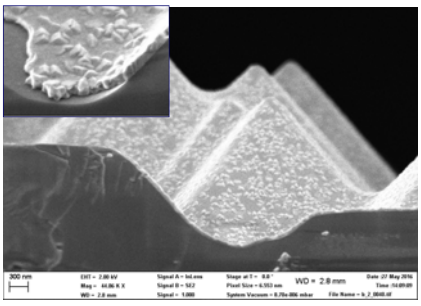
1. Form boron & phosphorus doped (p^+ and n^+-type) c-Si regions
   → $POCl_3$ and BBr_3 diffusions in tube furnace (Tempress systems)
2. Etch SiO_2 in diluted hydrofluoric (HF) acid 1%
3. ALD of In_2O_3 (Oxford Instruments OpAL™) at 100 °C using InCp, H_2O and O_2 *Libera, Chem.Mater.23,2150 (2011)*



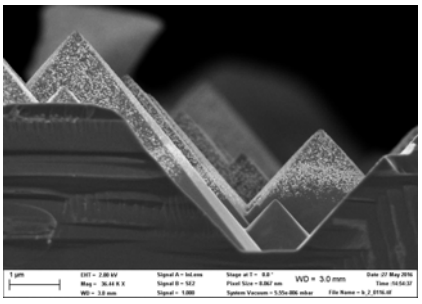
ALD In_2O_3

Results

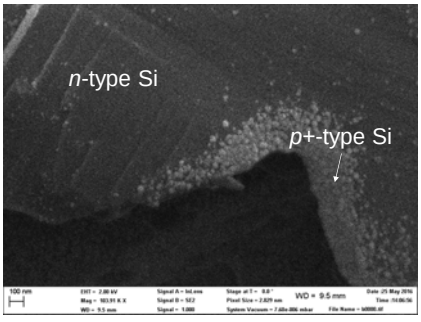
1. On p^+ Si there is a conformal layer of 75 nm In_2O_3 present
2. On planar *n*-type Si there is no growth at all of In_2O_3 (not shown)
3. On random-pyramid textured *n*-type Si, nucleation of In_2O_3 occurs on defect sites



Textured p^+-type Si: 75 nm In_2O_3



Textured n^+-type Si: nucleation of In_2O_3 (but no growth on planar *n*- *or* *n*+ -type Si)

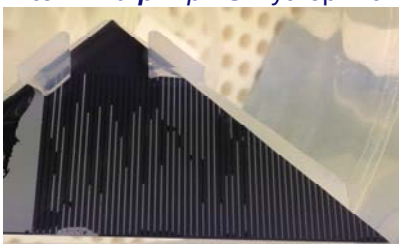


Area-selective ALD on *p*+-type Si regions

Mechanism

- p^+ Si remains hydrofylic after HF dip
- XPS shows native oxide is removed

-After HF dip→ *p*+ Si hydrophilic!



ALD In_2O_3

-After ALD: 75 nm In_2O_3 on *p*+ Si

Conclusions & Outreach

1. Concept of area-selective deposition based on doping level c-Si demonstrated.
2. The hydrophilic/hydrophobic nature of doped Si surfaces could open up possibilities for ASD using self-assembled monolayers.