SHAMAN: Shadow mask localization of thin films for back-contacted crystalline silicon solar cells & energy harvesters

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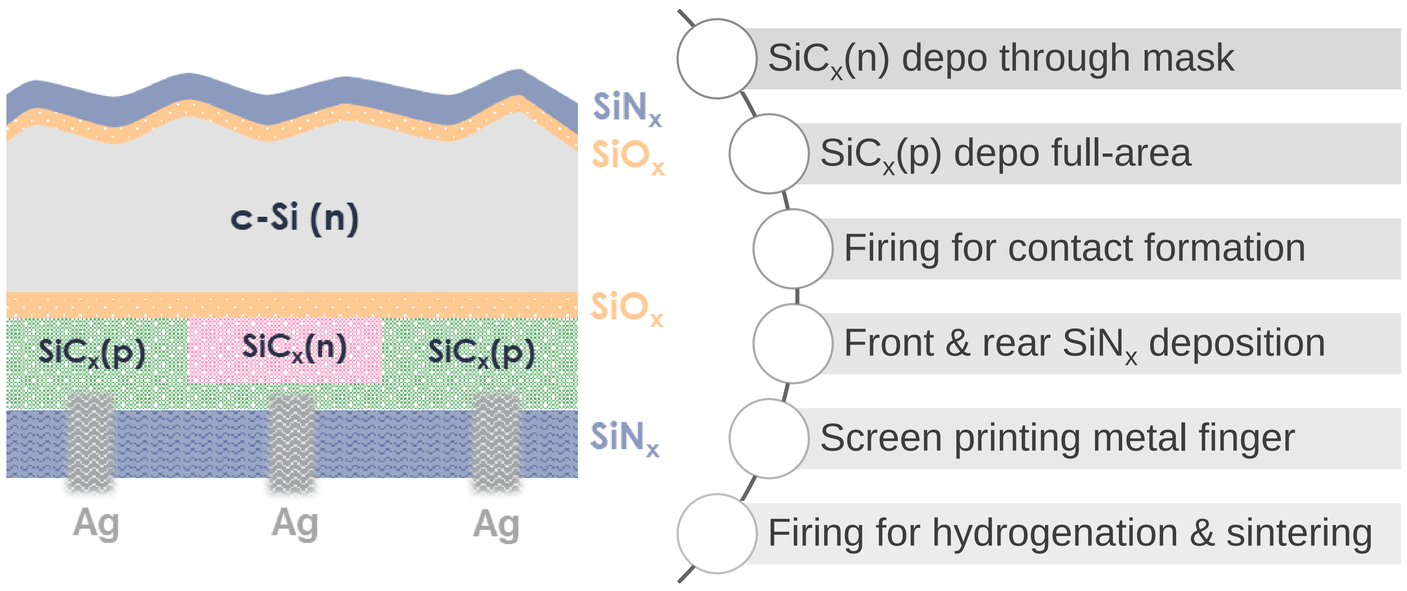
Interdigitated Back-Contacted c-Si Solar Cell Concept with High Temperature Stable Passivating Contacts

Motivation:

High efficiency potential of IBC cells with passivating contact has been demonstrated with efficiencies up to 26.1% using complex processing

→ Up to today there is no established simple way for fabrication of such solar cells

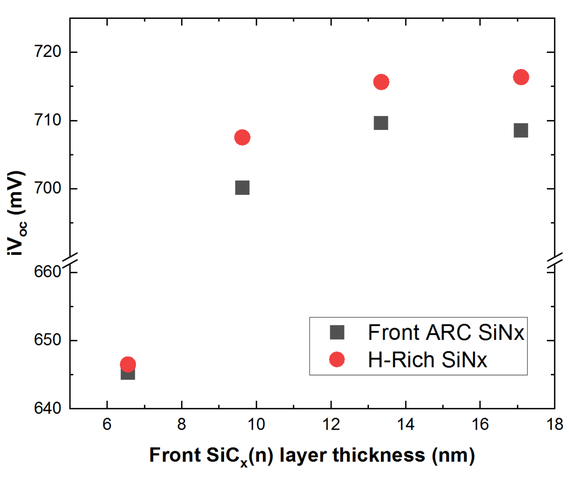
Target back contacted solar cell design and process flow:

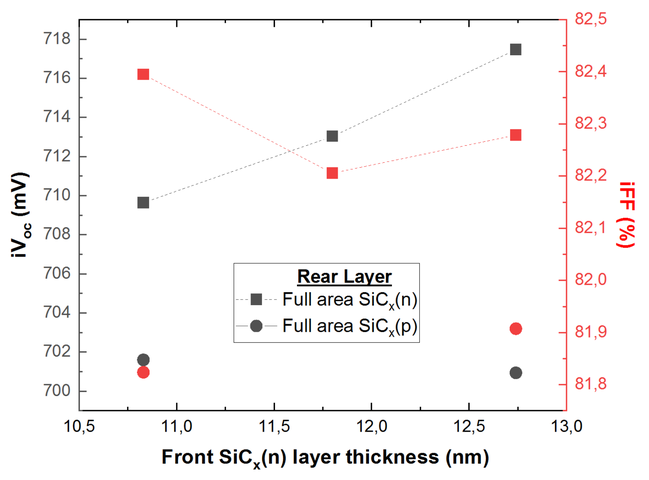


Advantages:

- Flexibility in material choice: Possibility to use low-cost base material thanks to high temperature treatment
  - Impurity gathering
  - Thermal donor killing
- Possibility to avoid TCO and compatibility with industrial firing-through direct metallization processes
- Potentially better compatibility for tandem application with perovskite top cell for 2TT applications

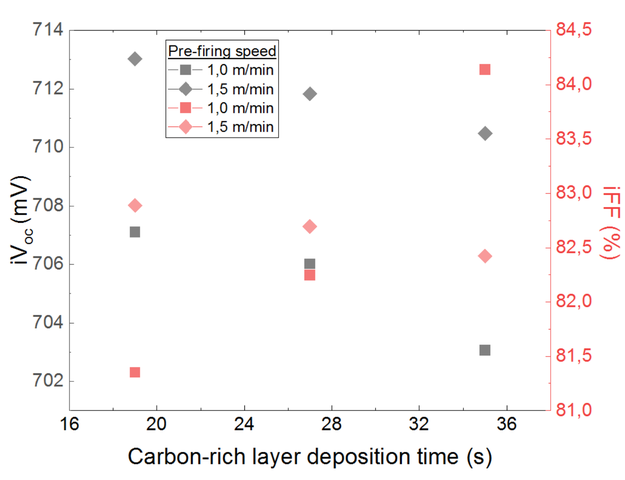
Front side optimization

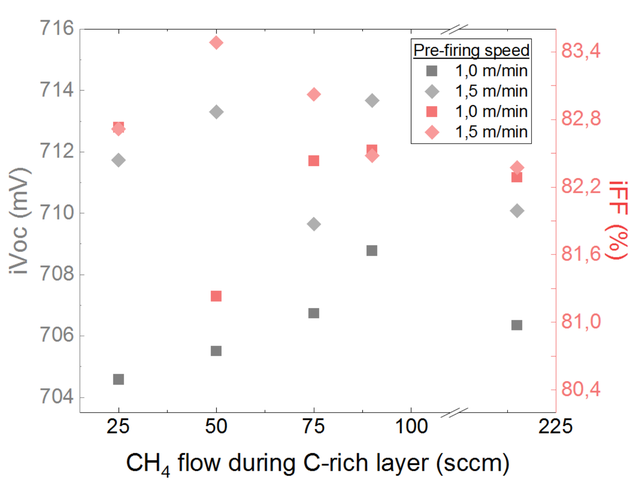




- Minimum and optimum thickness range for the front side is defined as 10 – 13 nm
- ARC - SiN_x optimized for front gives 6 to 8 mV lower iV_{oc} compared SiN_x optimized for hydrogenation
- Linear passivation dependence is observed as a function of front $SiC_x(n)$ layer (4mV/nm). This dependence is visible when the rear side has $SiC_x(n)$. When rear is covered with full $SiC_x(p)$ no clear dependence as the passivation is limited by the $SiC_x(p)$

Rear electron contact optimization





- Thinner the C-rich defective layer better the iV_{oc}

→ More efficient hydrogenation as less hydrogen can trap at the C-rich layer

- With increasing C-concentration, surface passivation improves but there is an optimum

→ Higher the C-concentration, higher the bandgap of the layer that can lead to favorable band bending

Conclusions & Outlook

- Front side $SiC_x(n)$ layer thickness optimization and rear electron contact optimization is realized leading to the cell precursors with iV_{oc} values up to 718 mV
- Proof of concept cell with efficiency up to 19.2% has been demonstrated with single shadow masking and firing process for contact formation of both polarities
- Next steps are (i) high temperature metallization development, (ii) further interface & layer optimization to improve V_{oc} and FF, testing different designs with various pitches

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