

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

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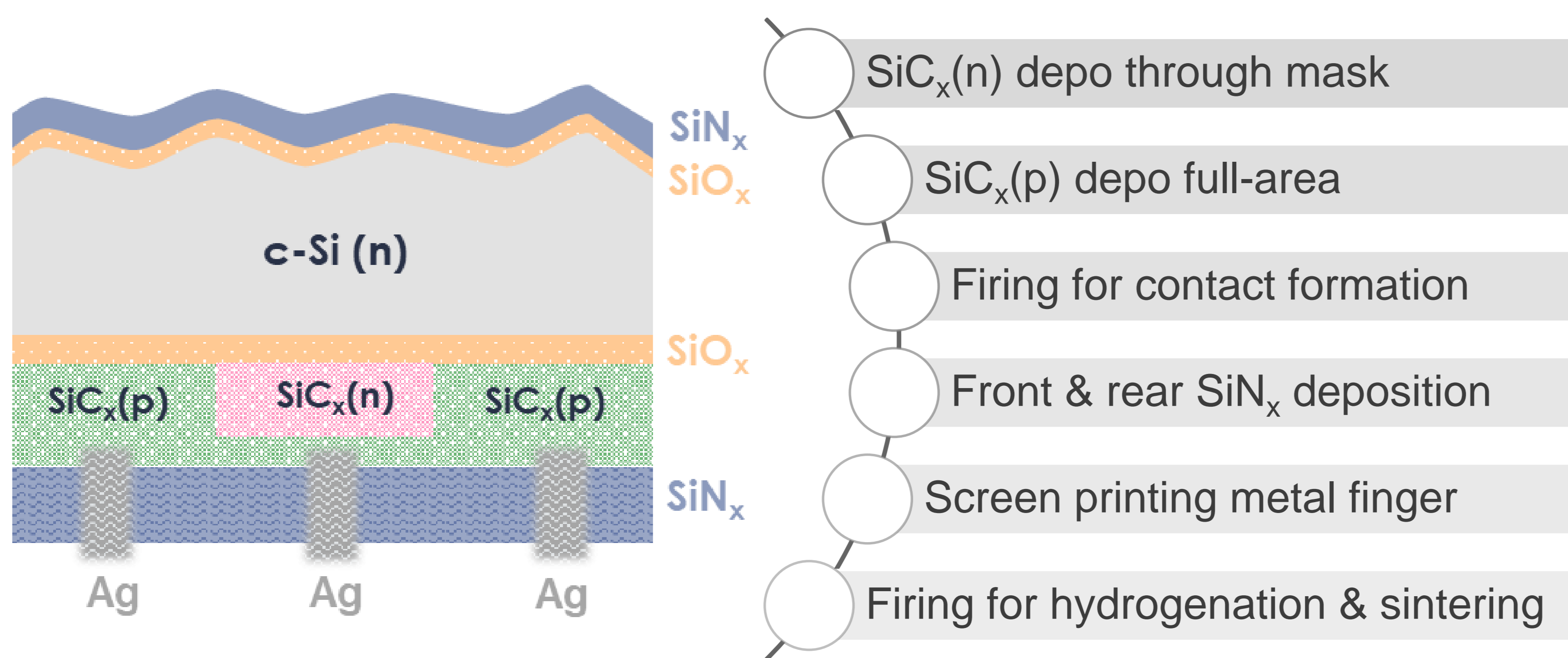
## Interdigitated Back-Contacted c-Si Solar Cell Concept with High Temperature Stable Passivating Contacts

### 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:

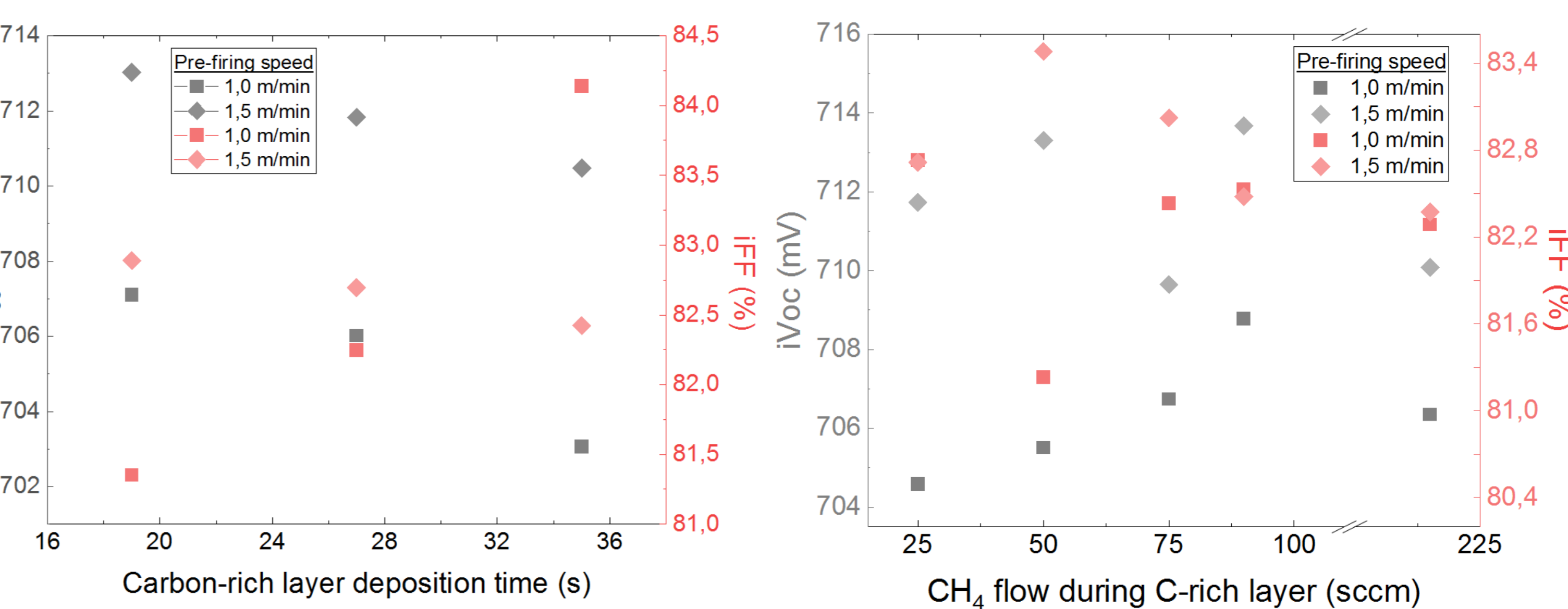
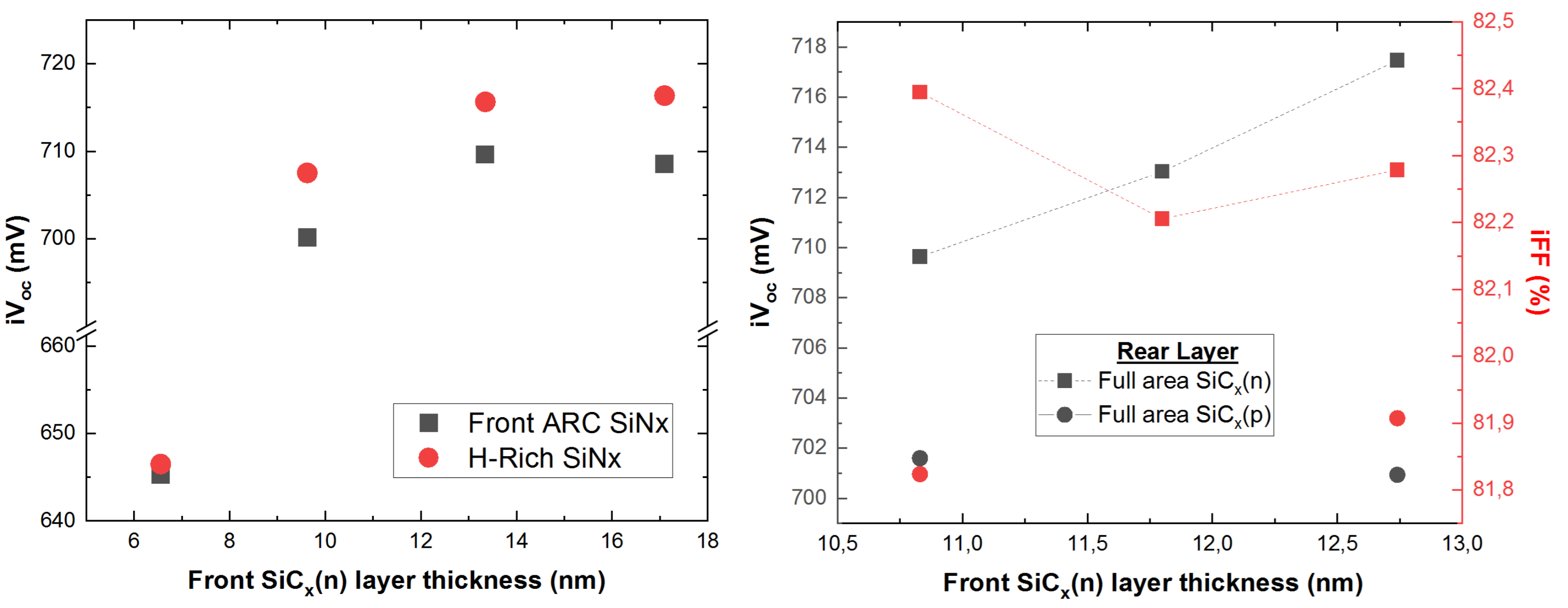


### Advantages:

- 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

### Rear electron contact optimization



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

- 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 SiCx(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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