



HAL
open science

ALD-grown SnO₂ as an electron selective layer for perovskite/silicon tandem cells

Félix Gayot, Matthieu Manceau, Elise Bruhat, Denis Mariolle, Eric de Vito,
Stephane Cros

► **To cite this version:**

Félix Gayot, Matthieu Manceau, Elise Bruhat, Denis Mariolle, Eric de Vito, et al.. ALD-grown SnO₂ as an electron selective layer for perovskite/silicon tandem cells. SiliconPV 2022 - 12th International Conference on Crystalline Silicon Photovoltaics, Mar 2022, Constance, Germany. , 2022. cea-04207613

HAL Id: cea-04207613

<https://cea.hal.science/cea-04207613>

Submitted on 14 Sep 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

ALD-Grown SnO_2 as an Electron Selective Layer for Perovskite/Silicon Tandem Solar Cells

Félix Gayot¹, Matthieu Manceau¹, Elise Bruhat¹, Denis Mariolle², Eric De Vito³, Stéphane Cros¹

¹ CEA LITEN – INES, 150 avenue du lac Léman, 73375 Le Bourget-du-lac ; ² CEA Leti, 17 avenue des Martyrs, 38054 Grenoble, France ; ³ CEA LITEN, 17 avenue des Martyrs, 38054 Grenoble, France

Context

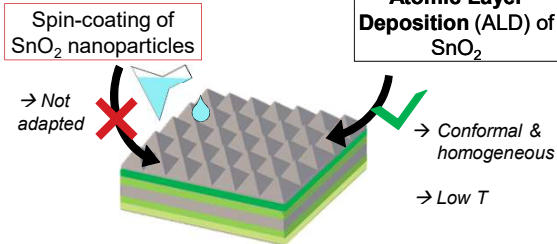
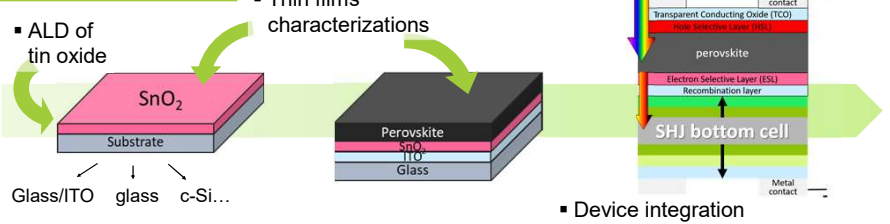


Fig. 1: Schematic of a pyramidal texture of a Si-HJT used as a bottom-cell in perovskite/Si tandem cells

Project summary



Goal: Unveiling the charge extraction limitations of a direct $\text{SnO}_2^{\text{ALD}}$ -perovskite interface

Could it work ?

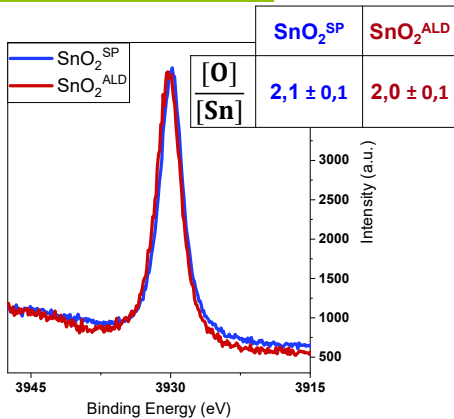


Fig. 2: HAXPES spectra centred on the Sn 2p binding energies of a solution-processed SnO_2 and an ALD-grown SnO_2 thin film & their respective $[\text{O}]/[\text{Sn}]$ ratio

ALD-grown oxide stoichiometry checked ✓

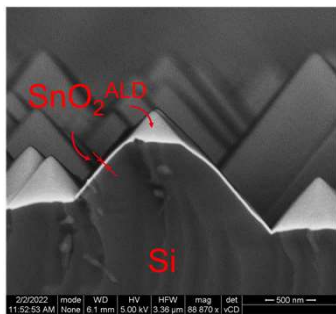


Fig. 3: SEM cross-section image of an ALD-grown SnO_2 thin film on a textured c-Si substrate

Dense & conformal ALD of SnO_2 ✓

$\text{SnO}_2^{\text{ALD}}$ transparent and highly conductive → [1] ✓

Behaviour of PK-based solar cells integrating an ALD-grown SnO_2 ESL

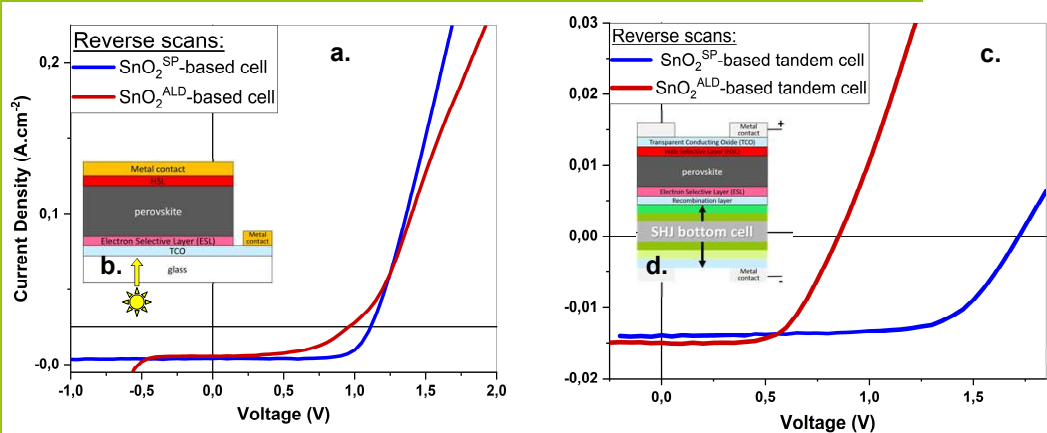


Fig. 4: $J(V)$ characteristics of single-junction (a) and perovskite/silicon tandem (c) cell integrating a reference SnO_2^{SP} ESL and a $\text{SnO}_2^{\text{ALD}}$ ESL. In inset of each graph, a schematic of a NIP single junction perovskite cell (b) and of a 2-terminal perovskite/silicon tandem cell (d) is shown.

Poor electron extraction & weak electron selectivity ✗

Limitations at $\text{SnO}_2^{\text{ALD}}$ /Perovskite interface

Perovskite grown on $\text{SnO}_2^{\text{ALD}}$ VS SnO_2^{SP} ?

➤ same optical bandgap, topography and crystalline structure [1] ✓

Interface Analysis

Table 1: Workfunction of $\text{SnO}_2^{\text{ALD}}$ & SnO_2^{SP} layers extracted from KPFM measurements

	SnO_2^{SP}	$\text{SnO}_2^{\text{ALD}}$
$\langle \Phi \rangle$ (eV)	$4,6 \pm 0,1$	$4,9 \pm 0,1$

$\Delta\Phi \sim 300$ meV

Significant workfunction difference ✗

➔ May generate an electron extraction barrier at the $\text{SnO}_2^{\text{ALD}}$ /Perovskite interface

Conclusion and perspectives

- ❖ Successful growth of SnO_2 by ALD
- ❖ Perovskite & perovskite/silicon tandem solar cells with an $\text{SnO}_2^{\text{ALD}}$ -based ESL show strong performance losses
- ❖ KPFM measurements unveiled a significant workfunction difference between $\text{SnO}_2^{\text{ALD}}$ layers and reference SnO_2^{SP} films

➔ Chemical characterisation of the $\text{SnO}_2^{\text{ALD}}$ /Perovskite interface may give further insight on the poor electron selectivity in devices

[1] Gayot et al., DOI:10.4229/EUPVSEC20212021-3BV.1.5