

# Tunnel Oxide Modification During PECVD Poly-Si Deposition for Passivating Contacts

Anatole Desthieux<sup>1,2,3,\*</sup>, Jorge Posada<sup>1,2</sup>, Davina Messou<sup>2,5</sup>, Barbara Bazer-Bachi<sup>4</sup>, Cédric Broussillou<sup>4</sup>, Muriel Bouttemy<sup>5,2</sup>, Pierre-Philippe Grand<sup>1,2</sup>, Gilles Goaer<sup>4</sup>, Etienne Drahi<sup>6,2</sup> and Pere Roca i Cabarrocas<sup>3,2</sup>

1. EDF R&D, Bvd Gaspard Monge, 91120 Palaiseau, France

2. Institut Photovoltaïque d'Ile-de-France (IPVF), 18 Bvd Thomas Gobert, 91120 Palaiseau, France

3. LPICM, CNRS, Ecole Polytechnique, Institut Polytechnique de Paris, route de Saclay, 91128 Palaiseau, France

4. Photowatt, EDF ENR PWT, 33 rue Saint-Honoré, Z.I. Champfleuri, 38300 Bourgoin-Jallieu, France

5. ILV, Université de Versailles Saint-Quentin en Yvelines, Université Paris-Saclay, CNRS, 78035 Versailles, France

6. TOTAL GRP, 2 Place Jean Millier – La Défense 6, 92078 Paris La Défense Cedex, France

\*. tel: +33 1 69 86 58 90, email: [anatole.desthieux@edf.fr](mailto:anatole.desthieux@edf.fr).

Crystalline silicon solar cells are the dominant technology in today photovoltaic (PV) market. In order to foster PV development, it is necessary to further reduce production costs as well as to increase cell efficiencies. A mainstream option to reduce recombination losses at the metal/semiconductor interface is the integration of so-called passivating contacts [1–3]. Passivating contacts consist of a silicon oxide ( $\text{SiO}_x$ )/doped polycrystalline silicon (poly-Si) stack that allows an outstanding surface passivation while providing a good conductivity for carrier collection and a low contact resistance. Cost reduction can also be reached by either limiting the overall thermal budget applied to the silicon wafer, using a single firing step to both metallize and anneal the cell [4], or performing sequential deposition of  $\text{SiO}_x$  and doped poly-Si layers by PECVD [5]. The coupling of these two approaches was studied in this work.

In order to avoid blistering during the firing step, the dilution of the  $\text{SiH}_4$  into  $\text{H}_2$  was increased for the deposition of the poly-Si layer. While the a-Si:H deposited with 10 sccm of  $\text{SiH}_4$  lead to the formation of many blisters,  $\mu\text{c-Si:H}$  deposited with 4 sccm of  $\text{SiH}_4$  gave blister-free samples after firing.

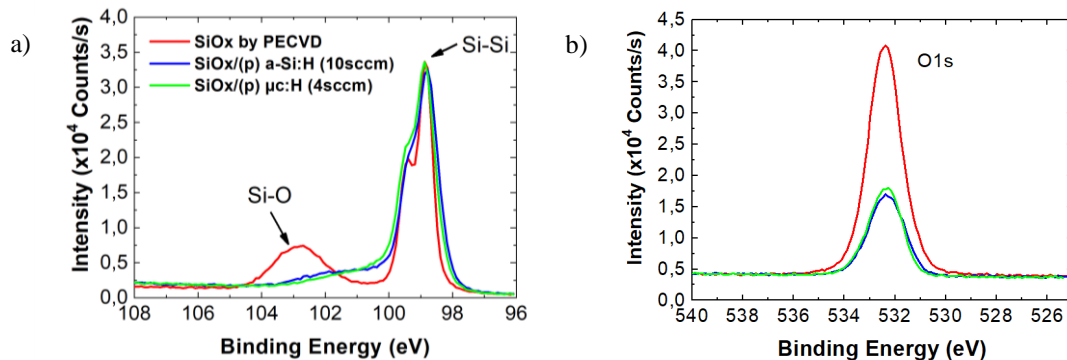


Figure 1: a)  $\text{Si}2p$  and b)  $\text{O}1s$  stacked spectra at the surface of the oxide layer for a reference PECVD  $\text{SiO}_x$  layer (no sputtering) in red, for two (p) Si PECVD/ $\text{SiO}_x$  PECVD/c-Si stacks, at the Si PECVD/ $\text{SiO}_x$  interfaces for a-Si:H (10 sccm) in blue and  $\mu\text{c-Si:H}$  (4 sccm) in green.

The impact of the PECVD deposition of the silicon layer on top of the  $\text{SiO}_x$  layer was investigated by XPS profiling. No remarkable thickness modification of the oxide layer was observed, but the oxide network was found to be notably modified with the appearance of a set of suboxides, characterized by the tail like shape on the left part of the  $\text{Si}2p$  peak. This comes along with a significant reduction of the oxygen content inside the oxide layer, as can be seen by the reduced intensity of the  $\text{O}1s$  peak. This evidences that the deposition method of the silicon layer for both a-Si:H or  $\mu\text{c-Si:H}$  on top of the  $\text{SiO}_x$  layer grown by PECVD modifies its chemistry, leading to oxygen removal, and changes in the oxidation degree.

The studied PECVD oxide integrated in a  $\text{SiO}_x$ /(p)  $\mu\text{c-Si/SiN}_x$ :H passivated contact with no annealing step does not provide good passivation, contrarily to a wet chemical oxide in such stack, which allows to reach an implied  $V_{oc}$  of more than 690 mV on p-type FZ polished wafers.

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