Characterization of Transition Metal Oxides as potential Hole Transport Layers (HTLs) for Two Terminal Perovskite / Silicon Heterojunction Solar cells

Pia J. Vasquez [a, b], Apolline Puaud[a], Delfina Muñoz [a], Muriel Matheron[a], Gema López [c], Isidro Martin[c], David Muñoz-Rojas[b]

(a) *Univ. Grenoble Alpes, CEA, Liten, Campus INES, 73375 Le bourget du Lac, France*
(b) *Univ. Grenoble Alpes, CNRS, Grenoble INP, LMGP, 38000 Grenoble, France*
(c) *Univ. Politécnica de Catalunya (UPC), MNT 08034 Barcelona, Spain*

Perovskite (PK) / Silicon heterojunction (SHJ) tandem solar cells have shown great developments during the last few years, with efficiencies reaching 29.5% in 2020[1]. The stability and market maturity of SHJ cells, combined with the versatility, rapid advances and potential low-cost of PK cells can offer a suitable solution to the increasing energy demand. Among the different possibilities for connecting the tandem subcells, the two terminal (2T) configuration allows cost reduction, enhanced light and structural coupling and reduced PV system weight. However, it also demands a finer optimization of layers in the cell stack[2]. A key component of the 2T tandem cells is the interconnection layer (IL), within which the charge carriers (electrons, holes) from one subcell are allowed to recombine with the opposite carriers from the other subcell. Several possibilities, including transparent conducting oxides (TCOs)[3], tunnel junctions[4] or direct interconnection between subcells[5] have been proposed. Whatever the solution, it is imperative to fulfil the optical, electrical and chemical requirements in order to ensure a high performance as well as a good stability and durability[6] of the tandem. In particular, IL should offer low parasitic absorption, low contact resistivities and chemical compatibility between the adjacent layers.

In this work, we have studied the optical, chemical and electrical properties of molybdenum and tungsten oxides (MoOx, WOx) deposited by thermal evaporation, to evaluate their integration as part of the IL between tandem subcells. These layers are known by their suitable properties as hole selective contacts[7]. Optical properties of the deposited layers such as low parasitic absorption and high optical bandgap ; electrical properties such as low contact resistivities and chemical compatibility between the adjacent layers are highly desired. Up to now, we have determined the optical constants and electrical properties of thin film TMOs deposited on glass, crystalline silicon, and on a microcrystalline silicon tunnel junction. Moreover, crystallization of a PK top cell deposited in the TMOs is studied by means of X-ray diffraction and its band-gap is determined by photoluminescence spectroscopy. Our results show that the studied TMO thin films are suitable candidates to integrate the interconnection layer in a 2T PK/SHJ tandem solar cell. With these results, we look forward to study the integration of these materials in functional 2T tandem cells, with further characterizations to fully understand the physical processes such as charge transfer, recombination and losses.

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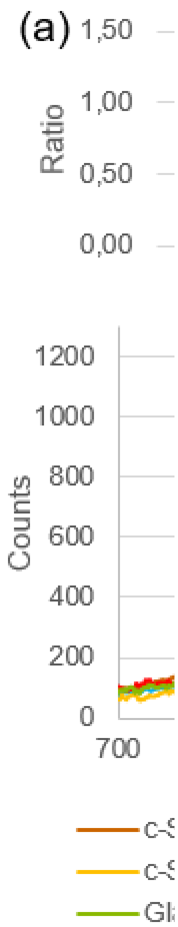

Figure 1(a) PbI2/crystallized PK ratio determined by X-Ray diffraction (b) Tandem stack analyzed, (c) PK bandgap around 770 nm (1.61 eV) determined by photoluminiscence spectroscopy