Deposition and Characterization of Strontium Vanadate and Strontium Niobate on Si Substrate for TCO applications

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The evolution of photovoltaics (PV) technologies is crucial to address global energy challenges, including reducing production costs and improving the efficiency of solar cells. Tandem cells, which employ multiple materials to capture a broader range of wavelengths from the solar spectrum, have emerged as a promising solution to enhance solar cell efficiency. However, their implementation requires optimization of selective contacts to facilitate electron transfer while blocking carrier recombination. In this framework, selective contacts and connection layers are crucial for ensuring an efficient interface between different layers of the solar cell, promoting the collection and transport of electric charges. Indium tin oxide (ITO) is often used as a transparent conductive layer in solar cells, but its scarcity and high cost are driving the exploration of alternative materials that can perform as well or better than ITO.

In our research, $SrVO_3$ and $SrNbO_3$ were initially selected for their unique electronic and optical properties, as well as their high figure of merit (Fig.1). With vanadium (V) in the $3d^1$ configuration, and niobium in $4d^1$ configuration, both materials exhibit metallic conductivity and high carrier concentrations (~10^{22} cm^{-3}) This leads to strong electron-electron correlations, allowing them to behave like metals while retaining a degree of optical transparency in the visible range [1], making them promising candidates for photovoltaic applications [3]. Using Pulse-Injection Metal-Organic Chemical Vapor Deposition (PI-MOCVD), we aimed to deposit the oxide films on Si substrates with precise control over parameters such as substrate temperature, gas flow rates, and precursor concentrations.

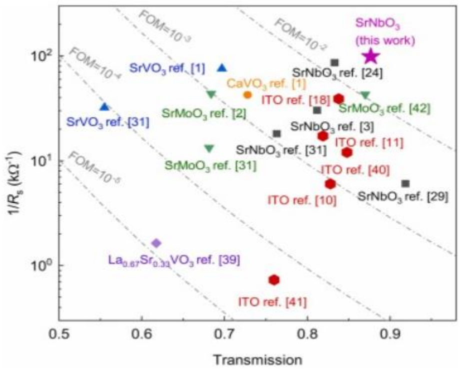

Fig.1: Reciprocal of sheet resistance versus the averaged transmission of reported TCOs thin films [2]

For the last year, we have been optimizing the two phases, we were able to reach a high stoichiometry of strontium and vanadium in our films, however, the desired phase was not obtained. We opted to anneal it under various conditions but the cubic phase was overshadowed by the hexagonal phase $Sr_3V_2O_8$ which seems to be more favorable under our growth and annealing conditions. On the other hand, as shown on figure 2 we were able to crystallize $SrNbO_3$ which is much stable under our growth conditions. This perovskite phase was obtained under various deposition temperatures even when the stoichiometric ratio was off. Additionally, the first electrical measurements showed relatively good conductivity. The structural morphological and electrical characterizations will be discussed according to the deposition and annealing condition.

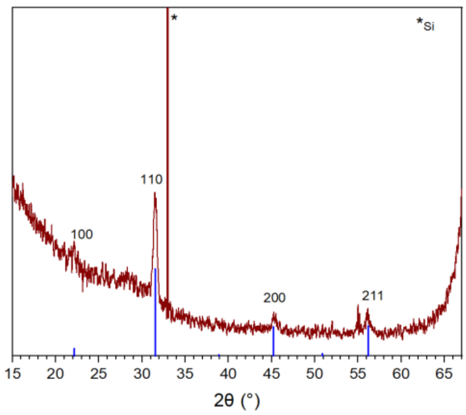

Fig.2: XRD of SNO deposited on silicon substrate

1. *Kumar, S. (2021). Theoretical and Experimental Studies of SrNbO3. SPAST Abstracts, 1(01).*
2. *Jeong, et al. « Transparent Conducting Oxides SrNbO3 Thin Film with Record High Figure of Merit ». Journal of the European Ceramic Society 44, nº 11 (2024): 6764-70.*
3. *Zhang et al. Nature materials. **2016**, 15, 204*

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