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Nb-DOPED TiO_2 FILMS FOR APPLICATION AS TRANSPARENT CONDUCTIVE OXIDE

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1. Introduction

Transparent conductive oxides (TCOs) such as ITO and FTO have been traditionally used in photovoltaic (PV) technology for their optical and electrical properties [1]. Specifically, ITO typically has a resistivity on the order of 10^{-4} Ω·cm [2]. Nb-doped TiO_2 (TNO) emerges as a promising alternative with similar high transmittance and low sheet resistance [3]. In such technology, these properties must be conciliated through a complex electronic structure optimization [3]. Plasma-assisted methods such as magnetron sputtering can be employed to achieve these goals due to its ability to control the material properties in atomic scale.

2. Experimental

TNO films were deposited by grid-assisted magnetron sputtering on glass substrates from a 4 inch target composed by Ti and different Nb inserts positioned along the target erosion zone. During the deposition, the substrate was maintained at floating potential. Depositions were made at room temperature and 300°C with one (0.8% Nb) and four (3.0% Nb) inserts. TiO_2 films were also obtained at the same temperatures for comparison. Target current, DC power, target-to-substrate distance, working gas, film thickness t, Ar and O_2 mass flow rate was kept, respectively, at 2.00 A, 1.0 kW, 6 cm, 0.80 Pa, 100 nm, 1.5 and 4.4 sccm. Films were evaluated by two-point probe method and spectrophotometry in the 190-1600 nm range.

3. Results and Discussions

Fig. 1 shows the transmittance for samples deposited at 300°C. Average transmittance for TiO_2 is 75% in the visible and 70% in the infrared range. Nb-doped samples have averages of 75% (visible) and 63% (infrared) for 1 Nb insert, and 73% (visible) and 63% (infrared) for 4 Nb inserts. Non-heated Nb samples averaged 78% in the visible and 66% in infrared. Resistivity for heated Nb samples was around 10^{-2} Ω·cm ($\rho = R_{sh}t$) whereas non-heated ones were close to 10^3 Ω·cm. The data suggests that Nb doping and heating conditions significantly impact both transmittance and resistivity.

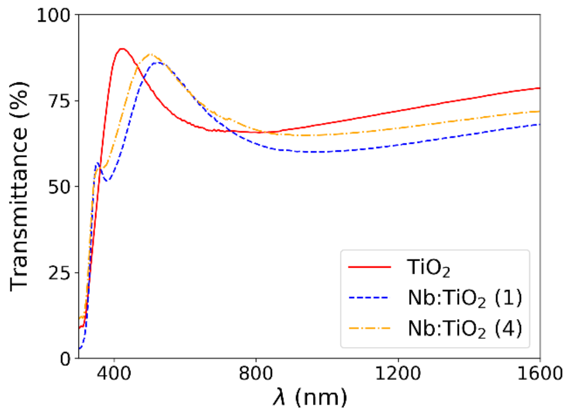

Fig. 1. *Transmittance for TiO_2 and Nb-doped TiO_2 films, deposited at 300°C using targets with 1 and 4 Nb inserts.*

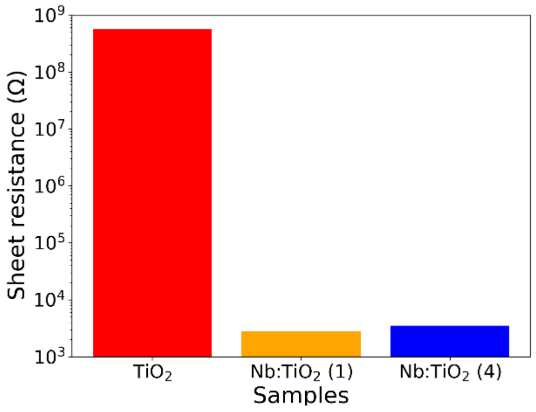

Fig. 2. *Sheet resistance (R_{sh}) for TiO_2 and Nb-doped TiO_2 films, deposited at 300°C using targets with 1 and 4 Nb inserts*

4. References

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