

# Transparent all-oxide hybrid NiO:N/TiO<sub>2</sub> heterostructure for optoelectronic applications

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Compact and mesoporous TiO<sub>2</sub> films were fabricated by spin coating following the standard procedure used when these layers are to be used as electron transfer layers for perovskites PVs. After the cleaning process of the FTO/glass substrate the compact TiO<sub>2</sub> (c-TiO<sub>2</sub>) film, having a thickness of around 60 nm, was formed which was followed by thermal treatment at 500°C for 15min in air ambient. A commercially available TiO<sub>2</sub> mesoporous paste was used to form the mesoporous (m-) TiO<sub>2</sub> on top of the c-TiO<sub>2</sub>/FTO/glass substrate. The m-TiO<sub>2</sub> layer formed was around 200nm thick which was afterward annealed at 500°C for 15min in air. The roughness of the m-TiO<sub>2</sub> surface was deduced from Atomic Force Microscopy (AFM) measurements and the results of such AFM measurements are seen in Figure S1. The RMS (root-mean-square) roughness for two different areas (3 μm x 3 μm and 10 μm x 10 μm) were 19.87 nm and 21.27 nm, respectively.

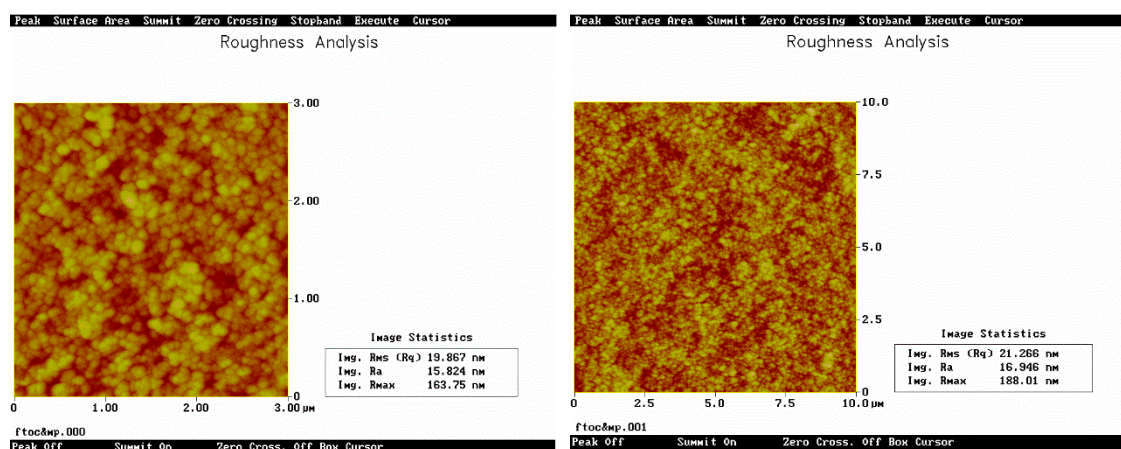


Figure S1. AFM measurements results of glass/FTO/c-TiO<sub>2</sub>/m-TiO<sub>2</sub> (500C)