Artificial Ageing of Thin Films of the Indium-Free Transparent Conducting Oxide $SrVO_3$

M. Mezhoud[1], M. Rath[1], O. El Khaloufi[1], O. Lebedev[1], J. Cardin[2], Ch. Labbé[2], F. Gourbilleau[2], V. Polewczyk[3], G. Vinai[3], P. Torelli[3], A. Fouchet[1], A. David[1], W. Prellier[1], and U. Lüders[1]

[1] Normandie Univ, ENSICAEN, UNICAEN, CNRS, CRISMAT, 6, boulevard du Maréchal Juin, F- 14050 Caen, France.

[2] CIMAP, CNRS, ENSICAEN, UNICAEN, Normandie Univ, 6, boulevard du Maréchal Juin, F-14050 Caen, France.

[3] Istituto Officina dei Materiali (IOM)–CNR, Laboratorio TASC, Area Science Park, S.S.14, km 163.5, I-34149 Trieste, Italy

The discovery of conductivity and transparency in unexpectedly strongly correlated ABO_3 materials has paved the path for the development of a new generation of indium-free transparent conducting oxides (TCOs). $SrVO_3$ [1], $CaVO_3$ [1], $SrNbO_3$ [2] and $SrMoO_3$ [3] perovskite oxides have demonstrated superior electrical and optical properties compared to Indium-Tin-Oxide (ITO), the standard material for TCOs market. Integrating these new TCOs materials on low-cost substrates for large-scale production remains a technological challenge because of the necessity of a compatible growth template for the crystalline growth of this new generation of TCOs [4], in contrast to ITO, which can be grown easily on industrial substrates and yet has good properties while being amorphous.

Another key factor that could limit the use of these new TCOs is their long-term stability, particularly for $SrVO_3$ (SVO), which is well known for its reactivity with oxygen since it exhibits a $3d^1$ unstable oxidation state of the V^{4+} [5-6]. To better understand the mechanism of degradation of SVO thin films, we performed artificial ageing on both epitaxial and polycrystalline thin films grown by Pulsed Laser Deposition (PLD) in order to investigate their long-term stability. Here, we will show the effect of heat treatments (150° to 250°C) under ambient environment on the structural, microstructural, electrical and optical properties of SVO thin films. Our results show that the technologically interesting TCO phase of SVO is destroyed at heat treatments at 250 °C and above, while for treatments at lower temperatures, the properties are modified, but the TCO character is preserved.

References

1. Zhang, L. *et al.* Correlated metals as transparent conductors. *Nat. Mater.* **15**, 204–210 (2016).

2. Park, Y. *et al.* SrNbO3 as a transparent conductor in the visible and ultraviolet spectra. *Commun. Phys.* **3**, 1–7 (2020).

3. Stoner, J. L. *et al.* Chemical Control of Correlated Metals as Transparent Conductors. *Adv. Funct. Mater.* **29**, (2019).

4. Boileau, A. *et al.* Highly Transparent and Conductive Indium-Free Vanadates Crystallized at Reduced Temperature on Glass Using a 2D Transparent Nanosheet Seed Layer. *Adv. Funct. Mater.* **32**, (2022).

5. Rath, M. *et al.* Artificial Aging of Thin Films of the Indium-Free Transparent Conducting Oxide SrVO 3. *ACS Appl. Mater. Interfaces* (2023) doi:10.1021/acsami.3c02421.

6. Polewczyk, V. *et al.* SI-Formation and Etching of the Insulating Sr-Rich V 5+ Phase at the Metallic SrVO 3 Surface Revealed by Operando XAS Spectroscopy Characterizations. *Adv. Funct. Mater.* **2301056**, 3–5 (2023).