

Nucleation and growth of Ag thin films: impact of seed layer and sputtering conditions

H. Montigaud¹, R. Lazzari², M. Balestrieri¹, R. Zapata^{1,2}, F. Corbella^{1,2}, Q. Herault^{1,2}, D. Guimard³

IT

¹Surface du Verre et Interfaces, UMR 125 CNRS/Saint-Gobain Recherche, 41 quai Lucien Lefranc, F-93303 Aubervilliers, France

²Institut des NanoSciences de Paris, CNRS/Sorbonne Université, F-75005 Paris, France

³Saint-Gobain Innovation Hub Europe, 41 quai Lucien Lefranc, F-93303 Aubervilliers, France

herve.montigaud@saint-gobain.com

Low-emissivity coatings used in energy-efficient glazing rely on ultra-thin silver (Ag) layers to reflect infrared radiation while maintaining high visible light transparency. Their thermal performance is directly linked to the electrical conductivity of the thin metallic layer (10nm). However, the resistivity of sputtered Ag thin films ($> \mu\Omega\cdot\text{cm}$) remains significantly higher than that of bulk silver ($1.62\mu\Omega\cdot\text{cm}$) due to electron scattering at the grain boundaries, intra-grain defects, and Ag film interfaces [1]. Improving the film microstructure during magnetron sputtering deposition is therefore a key challenge for obtaining optimized layers for the glass makers. Achieving such control requires a thorough understanding of the different growth mechanisms to identify and act on the key parameters related to the metal seed layer, the deposition conditions and the capping layer.

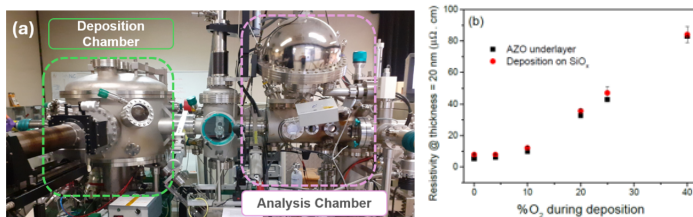


Figure 1: MISSTIC set-up at SVI (a), Ag film resistivity ($t=20\text{nm}$) on SiO_2 and AZO: evolution for different % O_2/Ar (b)

This presentation will primarily focus on the first two levers by reviewing the work carried out over recent years using the MISSTIC equipment at the SVI joint research unit (Fig. 1a). The different stages of Ag growth

on silica surfaces (SiO_2 being a reference amorphous oxide) will be discussed regarding the influence of the DC power applied [2], the deposition pressure, and the composition of the gas mixture used. A peculiar attention will be paid to the latter parameter, as the effect of adding nitrogen (N_2) or oxygen (O_2) to the plasmagen gas (Ar) on Ag film will be specifically discussed (Fig. 1b) [3,4]. These results will then be compared with those obtained when using an (Al doped) zinc oxide (ZnO) underlayer. Growing preferentially along the c-axis of the wurtzite hexagonal structure, ZnO exhibits an epitaxial relationship with the face-centred cubic structure of Ag. At last, this structural relationship will also be reviewed, in relation with the electrical conductivity of ultrathin Ag layers, typically around 12nm thick [5].

References

- [1] R. A. Matula J. Phys. Chem. Ref. Data, 8 (1979) 1147
- [2] Q. Herault PhD Sorbonne Université (2019)
- [3] R. Zapata et al. Appl. Surf. Sci. 654 (2024) 159546
- [4] R. Zapata et al. ACS Appl. Mater. Int., 15 (2023) 36951
- [5] F. Corbella et al. ACS Appl. Mater. Int. 17 (2025) 51431

QH, RZ and FC received a grant funded by Saint-Gobain Recherche and Association Nationale de la Recherche et de la Technologie.