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Electrochromic properties of various materials deposited on metallic nanowire networks as transparent electrode

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The global energy demand accounts for 30-40% of the total energy for the building sector. This energy is used for heating, cooling, lighting, and other purposes in residential and commercial buildings. Electrochromic smart windows are one of the promising solutions to minimize energy consumption in buildings and improve the inhabitants' indoor comfort.[1] Electrochromism refers to the ability of materials to change their optical properties, under an applied voltage, associated with a redox process.

Indium tin oxide (ITO) is extensively used as a transparent electrode for electrochromic devices owing to its high transparency, electrical conductivity, and chemical stability. However, some of the main limitations are its relatively high cost, scarcity, and brittleness, limiting its use in some applications. Silver nanowire (AgNW) networks appear as a promising alternative thanks to their high optical transparency, excellent electrical properties, and mechanical flexibility, and have indeed gained much attention in the last few years. However, the stability of AgNWs under electrical, thermal, and environmental stress remains a key issue for the applications.

The present work aims to prepare ITO-free electrochromic films using AgNW networks as a transparent electrode. The AgNW networks are deposited through spray-coating on transparent glass substrates, afterward, the electrochromic material is deposited using radio frequency magnetron sputtering, spin, or spray coatings. The stability of AgNWs under various deposition methods is studied. Bare AgNWs undergo degradation in sputtering conditions of electrochromic oxides. To avoid such degradation the AgNW networks are coated with a thin conformal protective oxide layer, ZnO and SnO₂, using atmospheric pressure spatial atomic layer deposition (AP-SALD) as shown in Figure 1.[2]

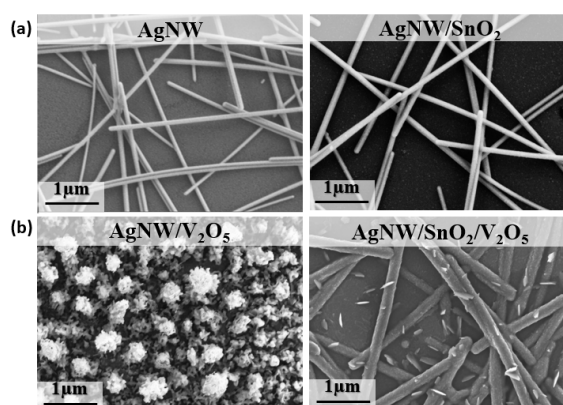


Figure 1. SEM micrographs of bare and coated AgNW used as substrate for sputtered V₂O₅ films.

The electrochromic performance of different electrochromic materials like vanadium pentoxide, tungsten trioxide, SurMOF, and PEDOT:PSS on AgNWs are investigated through cyclic voltammetry and chronoamperometry. The switching kinetics of AgNWs-based electrochromic films is studied by *in-situ* optical measurement and compared with the ITO-based ones. As an example, the switching time of RF-sputtered V₂O₅ films is reduced by half when replacing the ITO substrate with AgNW-based substrate.

References

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[2] A. Khan. *ACS Applied Mater Interfaces* **2018**, 10, 19208–19217.