Multifunctional Chromogenic and Transparent Conducting Oxide Nanocoatings

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Thin films with multiple functionalities are highly desirable. Examples include transparent coatings, where multiple physical properties must be met depending on application, e.g., conductivity (transparent-conductive oxides, TCO, for displays, low-emissivity coatings and electrodes), self-cleaning and heat management (solar energy and windows), and dynamic switching of transparency and colour modulation (chromogenic technologies for smart windows and displays). These coatings demand cooperatively acting multi-components pushing development of new materials and hybrid materials, as well as film deposition technologies. Here we show that functional inorganic coatings on transparent materials, fabricated by scalable and energy-efficient physical vapour deposition techniques, can be made using multi-layered functional transition metal oxide nanostructured thin films, nanocoatings. In the first part, we show two examples of advanced TCO nanocoatings: (1) Superficially oxidized, ultra-thin Ag-Pd-Cu films embedded between indium tin oxide layers in an oxide/metal/oxide configuration, yielding TCOs with superior transparency and maintained electrical conductivity [1]; and (2) nano-patterned indium tin oxide (ITO) embedded between thin amorphous ITO layers exhibiting selective suppressed thermal conductivity, with maintained electrical conductivity, excellent and adjustable transparency, yielding TCOs with high Seebeck coefficient and high Haacke's figure of merit, thus paving the way for thermoelectric functionalities of TCOs [2]. In the second part, we will focus on chromogenic materials, in particular on rare-earth oxyhydrides, which constitute a family of inorganic photochromic materials with promising applications in smart windows [3]. These oxyhydrides have been shown to be very stable in air and being able to retain hydrogen even when subjected to relatively high temperatures. Moreover, rare earth oxyhydrides exhibit very good photochromic optical contrast, dynamics and stability and could therefore be attractive alternative to conventional organic photochromic dyes. We discuss how such materials could be implemented as energy efficient window and display coatings.

References

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