Efficient and stable transparent electrodes based on silver nanowire networks: experimental and simulation approaches.

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Transparent electrodes (TE) are essential components in a huge variety of emerging applications such as photovoltaic, lighting, sensing and heating devices.[1,2] Indium tin oxide (ITO) has been the most efficient and widely used TE but suffers from serious limitations related to fabrication cost, brittleness and indium scarcity.[3] Among emerging transparent conductive materials (TCMs), metallic nanowire (MNW) networks, and especially silver nanowire (AgNW) networks, appear to be one of the most promising alternatives to ITO, since: i/ they exhibit excellent optical and electrical properties, ii/ they are very flexible, and iii/ they can be fabricated by low-cost, solution-based techniques suitable for large scale, industrial production.[4] Despite the advantages mentioned above, to build a robust and mature technology, there are still challenges to be tackled. Stability is a crucial issue that can be attributed to several degradation mechanisms involving electrical, thermal and mechanical aspects, ageing and chemical degradation.[5] Our present study focuses on the fundamental understanding of the physical phenomena that take place at different scales, from the whole network (macroscale) to the nanowire-to-nanowire junctions (nanoscale). Combining both experimental and modelling approaches, one of the main goals aims to understand the origin of failure in AgNW networks during electrical stress. *In situ* measurements of the electrical resistance with a parallel recording of the spatial surface temperature by IR imaging have yielded useful information about the failure dynamics of AgNW networks.[6] The simulation of the electrical distribution and power-induced heating offer a deeper understanding of the underlying physics and can be used to predict the networks electrical and heating performances.[7] Moreover, we observe the drastic enhancement of the electrical and thermal stability when we encapsulate the AgNWs networks with protective oxides such as ZnO, Al: ZnO (AZO) and Al_2O_3, using the Spatial Atomic Layer Deposition (SALD). This emerging open air, low-cost and scalable approach enables the deposition of ultrathin, high conformal and transparent oxide coatings at low temperatures.[8–10] Such work represents both fundamental and applicative aspects. For the latter, one aims to integrate AgNW based TE for instance in solar cells, transparent heaters, low-emissivity coating and energy harvesting devices.

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