ONE-PAGE ABSTRACT TEMPLATE AND GUIDELINES –TITLE CENTERED AND ALL CAPS

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Transparent conductive thin films (TCF) are widely used in electrical devices, especially for organic light-emitting diodes (OLED), screens & displays, solar cells and touch panels. TCFs must have low sheet resistance and high light transmittance. Generally, the materials used to make TCFs should behave low sheet resistance and high light transparency, typically the sheet resistance, Rs, should be ≤ 100 Ω/m2 with optical transmittance, T ≥ 90 %. The current industry standard material that is used to define these standards is indium tin oxide (ITO). For applications in flexible and stretchable electronics, such films must be resistant to damage after significant strain, a requirement that cannot be satisfied using ITO. Silver nanowire networks (AgNW) can show lower sheet resistance with higher light transmittance than ITO thin films; they also display a much greater strain to failure and greater resistance to mechanical damage. This study investigates the fatigue behaviour of AgNW networks with the objective of developing a fuller understanding of the damage mechanisms and how these can be developed into predictive models for lifetime determination.

Silver nanowires have been deposited onto flexible polymer substrates by spray coating to form a continuous stochastic network. Post-spraying treatment of either a low temperature anneal or a normal pressure is used to improve wire-wire electrical contact and reduce the network sheet resistance while maintaining optical transparency. The structural integrity of the film under flexible electronics service conditions has been assessed through repeated bending tests in a high cycle fatigue environment. Film electrical properties degrade with increasing cycle number, leading to a 40% increase in sheet resistivity after 5 × 106 cycles through a strain of ± 1.7%. This change in film electrical properties is correlated with observations of distributed local fracture events observed after testing by SEM studies of the fatigued networks. The fibre fracture events visible on SEM images can be quantified using an image analysis routine to count the number of fibres fractured during the bending process. These data can be used in conjunction with a model for the sheet resistance of stochastic conducting networks to predict the increase in resistance as a function of mean fibre length and hence correlated with the number of fractured fibres.