Highly Flexible Transparent Electrodes for Organic Light-Emitting Diode-Based Displays


The last decade has seen an increasing interest in building electronic devices on flexible substrates. Primary drivers for this include new functionalities, such as portable displays that could enable devices such as cell phones to be folded like wallets; or lower costs, such as solar cells that could be manufactured in a continuous, roll-to-roll process.

An ongoing challenge for this field is the fact that the highest performing electrical components are typically brittle inorganic thin films that are subject to cracking and failure when flexed. A specific case is the most commonly used material for transparent conductors, indium-doped tin oxide (ITO). The screen surface of flat displays requires coating with a transparent electrical conductor to make contact with the pixels, while enabling light transmission to the viewer. ITO is a thin film conductor with excellent optical transparency; however, it is subject to failure under moderate mechanical strain.

In this paper we demonstrate that multilayer ITO–silver–ITO stacks provide the same transparency as ITO, with increased conductivity. We were the first to show that the improved conductivity of the multilayer ITO enhances the efficiency of organic light-emitting diodes fabricated on them as compared with simple ITO electrodes.

Additionally, this was the first report to show that the inclusion of a thin, ductile metal film in the electrode stack substantially improves the mechanical robustness of the films under bending. This was demonstrated by showing a smaller radius at which cracking occurs for the multilayer stack, as well as better robustness under repeated bending cycles, compared with ITO.

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