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Quantitative analysis of bending fracture resistance of nanoscale Cu-buffered ZnO:Al thin films on a polymer substrate

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ABSTRACT

Improving the fracture resistance of fragile inorganic thin films under various bending conditions is critical in flexible thin-film systems. Here, we introduce a Cu-buffer-layer approach to evaluate the level of enhancement in the bending fracture behavior of Al-doped ZnO (AZO) thin films on the basis of quantitative mechanical parameters such as fracture energy, film strength and fracture toughness. These fracture behaviors of thin films sputter-deposited onto polyethersulfone substrates were observed to depend largely on the thickness of the Cu buffer layer. In the case of thin films with a 20 nm-thick Cu buffer layer, crack-initiating bending strain was substantially improved from ~1.04 % to ~1.37 %; this corresponds to an improvement of ~31.7 %. The substantial improvement is attributed to the presence of the Cu buffer layer, which helps prevent the formation of cracks by absorbing crack-initiating tensile stress. The calculated values of fracture energy and film strength support well the Cu thickness dependence of fracture behavior under bending operation.

Keywords:
Flexible electronics, Cu layer, ZnO thin films, bending fracture, critical strain, TCO

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