# All-Solution Processed Flexible Transparent Electrodes for Thin Film Photovoltaics

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Flexible organic optoelectronic devices such as organic solar cells, perovskite solar cells and organic light-emitting diodes require transparent conducting electrodes (TCEs) having high transparency and conductivity be fabricated on plastic substrates. Indium tin oxide (ITO), the material most commonly used in display industry, are not the most suitable for the fabrication of flexible devices because it is brittle and cracks easily under bending stress. At present, several classes of flexible transparent electrodes, including those based on graphene, metal nanowires, conducting polymers, and carbon nanotubes are being investigated. However, despite their strong potential as replacements for ITO, these materials suffer from the classic trade-off between optical transmittance and electrical conductivity. Thicker layers afford higher conductivity, but this increase comes at the expense of optical transmittance and vice versa. In addition, large-area organic devices built using flexible TCE based on these materials exhibit low efficiency, owing to the low conductivity of TCEs, in the absence of additional metal grids.

We have developed all-printed flexible TCEs by using a combination of Ag grid and transparent electrodes embedding architecture into plastic substrate, leading to highly transparent (optical transmittance ≈ 90%), highly conducting (sheet resistance ≈ 20 Ω $\square^{-1}$), highly smooth (root-mean-square roughness ≈ 0.5 nm), and extremely flexible (bending radius ≈ 500 μm) electrodes. These electrodes used to fabricate flexible organic and inorganic thin film solar cells that exhibited performances similar to that of devices fabricated on glass substrate. Moreover, the flexible devices did not show degradation in their performance even after being bended with a radius of ~500 μm.

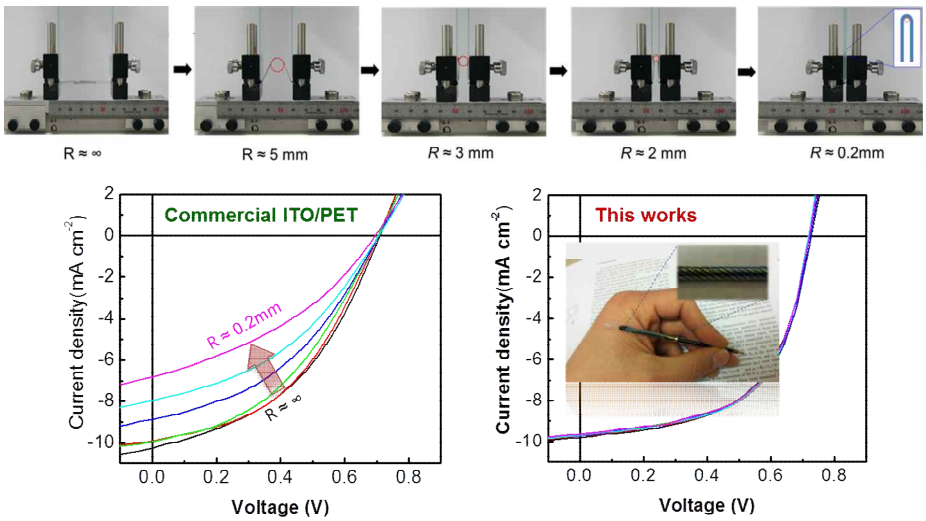


**Fig. 1. Bending tests of flexible solar cell fabricated on commercialized ITO/PET and all-printed TCE (this works).**