Graphene transparent conductive electrodes doped with $AuCl_3$ for highly-flexible perovskite solar cells

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Recent active studies on flexible photovoltaic cells strongly call for matchable flexible transparent electrodes. Graphene is one of the promising candidates as transparent conductive electrodes (TCEs) for flexible photovoltaic cells, but high sheet resistance of pristine grahene sheet limits the efficiency of the cells. In addition, it is important to maintain the characteristics of the electrodes even after repeated bending in flexible devices. Here, we coated $AuCl_3$ on the graphene surface and APTES (3-aminopropyl triethoxysilane) material between the graphene and the PET substrate to reduce the sheet resistance of the graphene and improve adhesion between the graphene and the substrate. After $AuCl_3$ doping concentration, the sheet resistance decreases ~ 80 ohm/sq while the work function increases ~ 4.78 eV, resulting in a power conversion efficiency (PCE) of 17.9%. In addition, the bending flexibility of the $AuCl_3$-doepd graphene/APTES/PET substrate, thereby maintaining the initial PCE of the solar cell over 75 % even after 1000 bending cycles at a curvature radius of 4 mm.