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Use of Doped-Graphene Transparent Conductive Electrodes for High-Performance Si-Quantum-Dots-Based Solar Cells

Recently, various kinds of graphene/semiconductor heterojunction devices have been intensively studied due to the outstanding properties of graphene such as perfect transparency, high carrier mobility, and easy adjustment of the Fermi level by doping [1]. Even though Si is a principal material in semiconductor industries, it is of limited use in optoelectronic device applications because of the small- and indirect-bandgap nature [2]. To overcome this problem, Si quantum dots (SQDs) have been employed in optoelectronic devices based on quantum confinement effect [3]. Here, we employ doped-graphene transparent conductive electrodes (TCEs) for SQDs-based solar cells. Three kinds of dopants such as gold (III) chloride ($AuCl_3$), silver nanowires (Ag NWs), and bis(trifluoromethane sulfonyl)–amide (TFSA) are employed for efficient collection of the carriers photo-induced in SQDs. The TFSA-doped graphene TCE/SQDs solar cells show maximum power conversion efficiency (PCE) of 16.61%, much larger than ever achieved in their counterparts with metal TCEs. In particular, the long-term stabilities of the solar cells are remarkably improved by using TFSA for the graphene TCEs. After 700 h, the solar cells show 3.05/18.57/10.84% degradation from their initial PCEs for the TFSA/Ag NWs/$AuCl_3$-doped graphene TCEs, respectively. These results are very promising for the applications of the doped graphene TCE/SQDs heterojunctions in optoelectronic devices.

References

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[2] L. Pavesi, L. D. Negro, C. Mazzoleni, G. Franzò, and F. Priolo, Nature, 6811 (2000) 440-444
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Figures

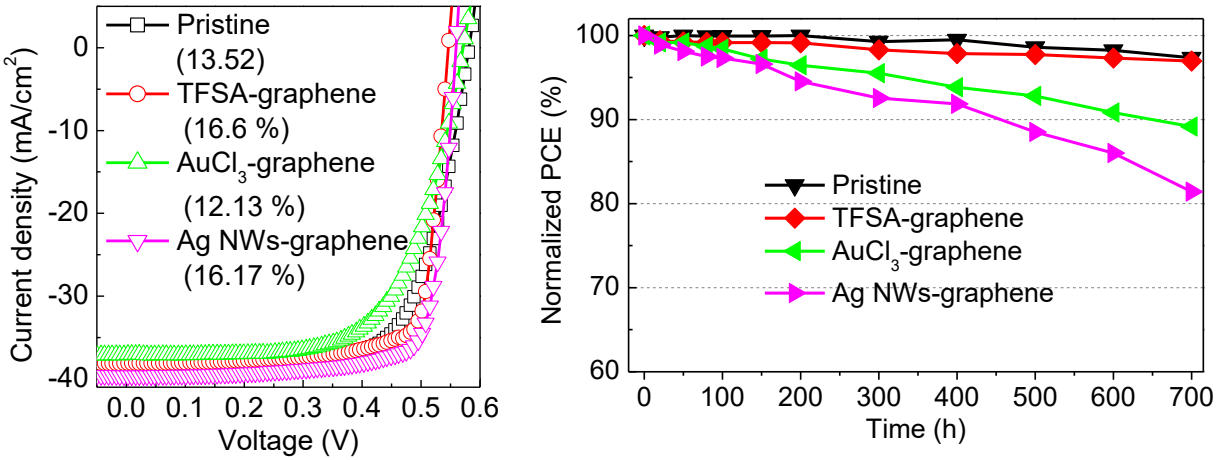

Figure 1: Photo J-V curves and long-term stabilites of the solar cells with TFSA/Ag NWs/Au Cl_3-doped-graphene TCEs. Here, PCEs are indicated.