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•HIGHLIGHTS•

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Silver nanowire flexible transparent electrode toward commercialization

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With increasing demand for integrated photovoltaics and as power sources for portable and wearable devices, flexible organic solar cells (OSCs) have aroused great interests in the academic and industrial communties [1]. However, the efficiency of flexible OSCs is significantly lower than that of their rigid counterparts because of the unfavorable optoelectronic/mechanical properties of flexible transparent electrodes (FTEs).

In the last few years, silver nanowires (AgNWs) have been widely used to fabricate FTEs using solution process due to their high conductivity, high light transmission, and robust bending durability. However, the randomly stacked AgNWs with loose contacts cause a high contact resistance, limiting the conductivity of the AgNW-based FTEs [2]. Therefore, precisely controlling AgNWs junction-site formation to realize better metallic contact is crucial for decreasing the sheet resistance (R_{sh}) of the AgNW-based FTEs [3,4].

Recently, a chemical welding strategy for realizing robust physical/electrical contact at AgNWs junction-site was proposed by Li *et al*. [5] from Soochow University, China. In this work, they employed an ionic-liquid (IL)-type reducing agent to precisely control the *in situ* reduction process of Ag^+ to chemically welding the contatc points of AgNWs. The Cl^- anions in the IL regulate the Ag^+ concentration and the dihydroxyl group on the IL molecule reduces *in situ* the slowly released Ag^+ (graduatelly released from AgCl) to form metal Ag (Figure 1a) at the contact points of AgNWs. The fine-tuned controllable Ag^+ reduction at the junction site of the AgNWs tightly weld the junction sites of the AgNWs and further realize an atomic-level contact between them to forms an additional "AgNW-reduced Ag-AgNW" conductive pathway (Figure 1b). When combined with PET/Embedded AgNW (PET/Em-Ag) substrate, the resulted PET/Em-Ag/AgNWs-IL FTE demonstrates a low R_{sh} of 12 Ω/sq, along with the highest transmittance of 95% at 550 nm (excluding PET substrate). And the flexible OSC based on the FTE achieved a record PCE of 17.52% (Figure 1c, d) using the PM/Y6 pair active materials, essentially similar performance as that on the rigid ITO electrode. In addition, the fabrication of this FTE has been expanded to facilitate large-scale blade-coating device (Figure 1e) and a high PCE of 15.82% was obtained for the 1-cm^2 flexible OSC (Figure 1f).

This is an original work enabling the AgNWs junctions combination at atomic level during solution process, thus providing a feasible way to address the bottleneck of high-performance FTEs at large area. It may fundamentally promote the development of flexible optoelectronic devices toward commercialization.

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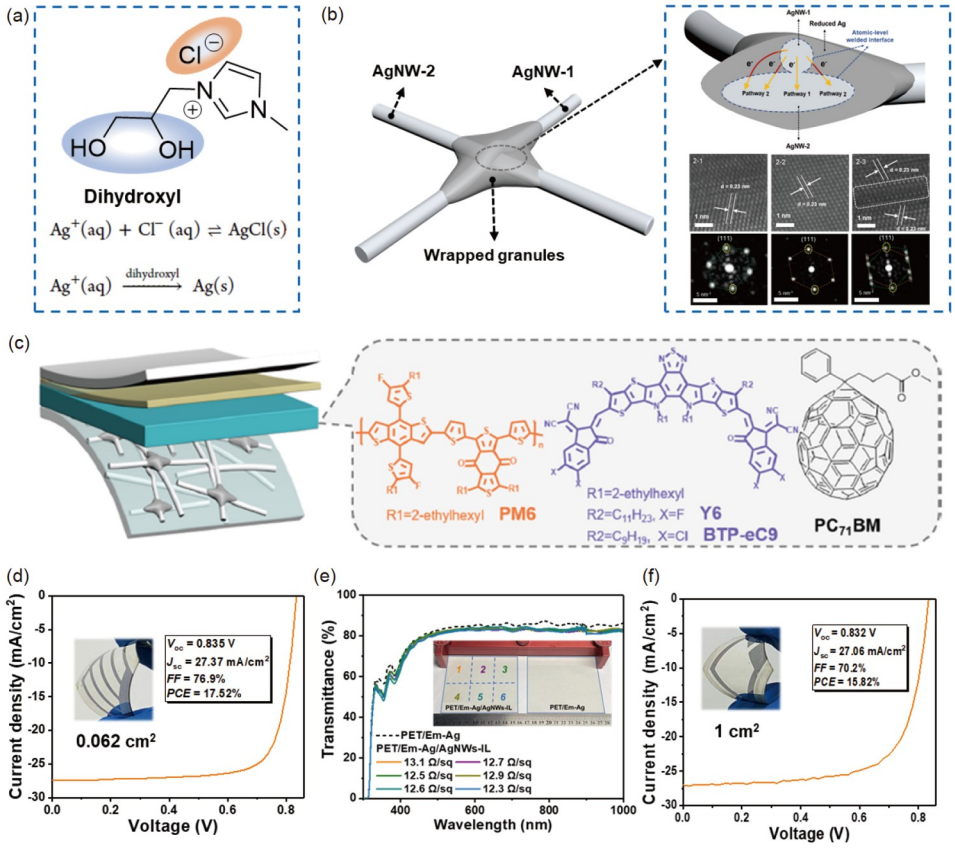

Figure 1 (a) Chemical structure of the IL. (b) Schematic diagram of the junction site of the AgNWs. (c) Schematic illustration of a flexible OSC and molecular structures of the donor PM6 and acceptors Y6, BTP-eC9, and $PC_{71}BM$. (d) *J*-*V* curves of the 0.062-cm^2 control and target flexible OSCs under AM 1.5G 100 mW/cm^2 illumination. Inset: photograph of the 0.062-cm^2 flexible OSC. (e) Transmittance and R_{sh} of six different regions on a large-area FTE with the structure of PET/Em-Ag/AgNWs-IL (inset: optical photographs of the large-area FTE). (f) *J*-*V* curves of the 1-cm^2 control and target flexible OSCs under AM 1.5G 100 mW/cm^2 illumination. Inset: photograph of the 1-cm^2 flexible OSC [5] (color online).

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