

화학과 정례 세미나 안내

일시 : 03월 03일 오후 5시 10분

장소 : 자연대 1호관 1214 강의실



제목 : Material Design for Stretchable All Polymer Solar Cells

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미국화학회지 (ACS) Chem. of Materials 및 영국화학회지 (RSC) J. Mater. Chem. A 및 Materials Advance 편집자문위원,

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Abstract

Material Design for Mechanically-Robust, Stretchable Polymer Solar Cells

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The mechanical robustness of polymer solar cells (PSCs) is of great importance to ensure the long-term stability and enable their use as power-generators in flexible and stretchable electronics. Here, we present a comparative study of the mechanical properties of small-molecule acceptor (SMA)-based, polymer acceptors (PA)-based, and fullerene-based PSCs. We chose ITIC, P(NDI2OD-T2), and PCBM as three representative acceptor materials and blended them with the same polymer donor. To understand the difference between the mechanical properties of SMA-based and PA-based PSCs, we control the number-average molecular weight (M_n) of P(NDI2OD-T2) from 15 to 163 kg mol⁻¹ in all-PSCs. The high M_n PA-based-PSCs exhibited a high strain at fracture of 31.1%, which is 9- and 28-fold higher than those of SMA-PSCs and PCBM-PSCs, respectively. The superior mechanical robustness of all-PSCs is attributed to using a PA above the critical molecular weight (M_c), which produces tie molecules and polymer entanglements that dissipate substantial mechanical strain energy with large plastic deformation. The connectivity between the crystalline domains generated by PA tie chains leads to high charge mobilities and photovoltaics performances of all-PSCs. Also, this feature explains very high donor:acceptor composition tolerance of all-PSCs in the photovoltaic and mechanical performances. Therefore, our work highlights the importance of incorporating high M_n PAs above the M_c for producing the PSCs with excellent mechanical robustness and device performance.