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2-Dimensional inverse opal structured VO_2 thin film for selective reflectance adjustment

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Vanadium dioxide (VO_2) is a well-known material that exhibits a metal-semiconductor transition at 340 K, with drastic change of transmittance at NIR region. However, VO_2 based thermochromics accompany with low visible transmittance value and unfavorable color (brownish yellow). Herein, we demonstrate the adjustment of visible transmittance of VO_2 thin film by nanosphere template assisted patterning process using sol-gel method. 2-Dimenstional honeycomb shape was varied as function of diameter of nanosphere and coating conditions. The morphological geometry of the films was investigated by FE-SEM and AFM. Result shows that inversed shape of nanosphere was formed clearly and pattern width was altered according to the bead size. This structure creates the geometrical blank area from the position of nanosphere which improves the optical transmittance at the visible region. Moreover, such patterned VO_2 thin film not only maintains the optical switching efficiency, but also generate the gorgeous scattering effect which presumably support the glazing application.

Keywords: Thermochromic, Colloidal lithography, Vanadium dioxide, Smart window

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Towards Thermally Stable Tandem Organic Solar Cells

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Tandem structure is promising in organic solar cells because of its double open-circuit voltage (VOC) and efficient photon energy conversion. In a typical tandem device, the two single sub-cells are stacked and connected by an interconnecting layer. The fabrication of two sub-cells are usually carried out in a glovebox filled with nitrogen or argon gas, which makes it expensive and laborious. We report a glovebox-free fabricated inverted tandem organic solar cells wherein the tandem structure comprises sandwiched interconnecting layer based on p-doped hole-transporting, metal, and electron-transporting materials. Complete fabrication process of the tandem device was performed outside the glove box. The tandem solar cells based on poly(3-hexylthiophene) (P3HT) and (6,6)-phenyl C61-butyric acid methyl ester (PCBM) can realize a high VOC, which sums up of the two sub-cells. The tandem device structure was ITO/ZnO/P3HT:PCBM/ PEDOT:PSS/MoO3/Au/Al/ZnO-d/P3HT:PCBM/PEDOT:PSS/Ag. The separate sub-cells were morphologically and thermally stable up to 160 oC. The high stability of the active layer benefits in the fabrication processes of tandem device. The performance of tandem organic solar cells comes from the sub-cells with an 50 nm thick active layer of P3HT:PCBM, achieving an average power conversion efficiency (PCE) of 2.9% (n=12) with short-circuit current density (JSC) = 4.26 mA/cm2, VOC = 1.10 V, and fill factor (FF) = 0.62. Based on these findings, we propose a new method to improve the performance and stability of tandem organic solar cells.

Keywords: Organic solar cells, Inverted tandem solar cells, Interconnecting layer, Thermal stability