第111回　OPERA研究交流セミナー
第103回　ISIT有機光エレクトロニクス研究特別室セミナー
第170回　未来化学創造センターセミナー

日時：　2014年5月15日(木)　14:30-
場所：九州大学　最先端有機光エレクトロニクス研究棟　3F会議室

“Device engineering in organic solar cell: interface modification, morphology control and device architecture design”

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Organic photovoltaics (OPVs) are of great interest as an alternative renewable energy source to typical silicon-based photovoltaic cells due to their potential for cost-effective large-area manufacturing, light-weight, mechanical flexibility, and semi-transparency (ST) characteristics. Currently, the most efficient OPVs are based on the bulk-heterojunction (BHJ) architecture, in which an electron-donor (e.g., a conjugated polymer) is blended with an electron-acceptor (e.g., [6,6]-phenyl-C61-butyric acid methyl ester (PC61BM) or [6,6]-phenyl-C71-butyric acid methyl ester (PC71BM)) to form the active layer.

Due to the short exciton diffusion distance and low carrier mobility of organic semiconductors, the active layer with nano-scale phase separated interpenetrating network morphology is the prerequisite for high device performance of OPVs. Also, modification at the electrode/active layer interface to form Ohimic contact for selective single carrier while forbid the other at the electrode is critical. Sufficiently utilizing solar irradiation through device architecture design, e.g. micro-cavity confinement effect, tandem deivce, etc., shows the potential to explore the ultimate device performance of OPVs.

Here, we studied the effect of conjugated polymer micro-gels on the morphology and device performance of OPVs. Also we developed a novel immerse precipitation method to control the phase separation kinetics. The incorporation of C60-SAM as buffer layer at ZnO further improved the device performance. Combining both morphology control and interface modification, we developed high performance tandem solar cells with power conversion efficiency (PCE) up to 8.5%, and semitransparent tandem solar cell with PCE ~7.4% while still had a averaged transmittance ~40% in the visible region. Further, by incorporating miro-cavity effect in tandem architecture, we developed parallel tandem solar cells with PCE ~ 9.2%, and series tandem solar cells ~ 10.6%.

主催：九州大学　最先端有機光エレクトロニクス研究センター
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