Development of Advanced High-Performance Organic Photovoltaic Device

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Famous phenomenon, such as photo-induced charge transfer, is fundamental mechanism in polymer photovoltaic devices.

Fundamental Structures of D-A Type Photovoltaic Cells

(a) Bi-layer type
(b) Bulk Heterojunction
(c) p-i-n Junction Type
(d) Interpenetrating Junction
Device Performance of Interpenetrating Junction Devices

- High hole mobility
- Wide range absorption
- High electron mobility
- 75% at peak

EQE: External Quantum Efficiency

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Device Performance of Interpenetrating Junction Devices

**Energy conversion efficiency: 1.0%**

**Graph:**
- **ITO / C<sub>60</sub> / PAT6 / Au**
- **ITO / ZnO / C<sub>60</sub> / PAT6 / Au**

**Diagram:**
- Conducting polymer
- C<sub>60</sub>
- ZnO
- ITO
- Quartz Substrate

**Energy Levels:**
- HOMO
- LUMO

**References:**

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In our study, we focus on the fundamental structures of D-A type photovoltaic cells. These cells are categorized into four types:

1. **Bi-layer type** (a) - The structure consists of an ITO electrode, a donor layer, an acceptor layer, and another ITO electrode. The layers are arranged in a sandwich-like configuration.

2. **Bulk Heterojunction** (b) - This type features a donor layer mixed with an acceptor layer within the same material. ITO electrodes are placed on both sides.

3. **p-i-n Junction Type** (c) - Here, the active layer is divided into p, i, and n regions, each with different properties. ITO electrodes are on both sides.

4. **Interpenetrating Junction** (d) - This structure involves interpenetration of donor and acceptor materials, with ITO electrodes on both sides.

These configurations play a crucial role in the efficiency and performance of photovoltaic devices.
Device Performance of Bulk Heterojunction Devices

ITO/PEDOT:PSS/PAT6:PCBM/Al

90% at peak

\[ \eta = 3.06\% \] under AM1.5
Previous Publications

**Fundamental Study**


**Solvent Effects**


**Design of Inverse type Structure**


**Fundamental Interface Studies**


**Mixed Solvent Effects**


**ITO Surface Modification Effects**


**Co-evaporation Layer and Wide Range Sensitivity**


**Insertion of Oxide Semiconductor Layer**


**Film Fabrication by Spray Method**
Future Plans

We try to Investigate as follows for realizing high performance organic photovoltaic devices.

1. Modification of interface structures
2. Crystal growth
3. Buffer Layer Effects
4. Optimization of anode material
4’. Optimization of cathode material
5. Nano-structured surface of electrode
6. Reduction of surface reflection

The detailed studies are now in progress.
Collaboration in our IDER unit

A. Fujii and co-workers (Ozaki Lab.)
Device Design, Fabrication and Measurement

M. Yoshimura (Mori Lab.)
Crystal Growth and Crystal Analysis

M. Abe (Morita Lab.)
Surface and Interface Analysis

R. Hidayat (Institut Teknologi Bandung, Indonesia)
Optical Analysis

W. Feng (Tianjin University, China)
Material Design and Synthesis

J. Sakai (Matsushita Electric Works)
Device Design, Fabrication and Measurement

Y. Shimizu (AIST)
Molecular Alignment Control and Carrier Transport Measurement

Overseas

In Campus

Out of Campus