

【Staff Members】

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【Research Activities】

Significant developments were achieved in 2004 in the area of organic transistors and carbon nanotubes.

In organic field effect transistors (OFET), we first demonstrated a method for intensive control of the channel carrier density using an interface doping technique with polar self-assembled monolayers (SAMs) (**Ref.1**). This observation was made not only on polycrystalline thin films (**Ref.1**) but also on single crystal devices (**Ref.2**), indicating that the interface doping in OFETs with SAMs is an intrinsic phenomenon free from extrinsic effects such as grain boundaries. We have also adopted an electrochemical transistor (ECT) technique to conducting polymers, and succeeded in a direct comparison between FET and electrochemical transistor operations in OFETs (**Ref.4**).

In carbon nanotubes, notable results were obtained in FET and optical properties. In multiwalled carbon nanotube devices, we have shown a gate electric field induced crossover from a localized to an extended state (**Ref.3**). In single-walled carbon nanotubes, on the other hand, we made a first demonstration of resonance enhancement of nonlinear optical response in collaboration with Okamoto group at University of Tokyo, and showed that the coherent process dominates in this enhancement (**Ref.5**).

1. S. Kobayashi, T. Nishikawa, T. Takenobu, S. Mori, T. Shimoda, T. Mitani, H. Shimotani, N. Yoshimoto, S. Ogawa, and Y. Iwasa
Control of carrier density by self-assembled monolayers in organic field-effect transistors
Nat. Mater., 317 (2004) 317-322.
2. J. Takeya, T. Nishikawa, T. Takenobu, S. Kobayashi, Y. Iwasa, T. Mitani, C. Goldmann, C. Krellner, and B. Batlogg
Effect of polarized organosilane self-assembled monolayers on organic single-crystal field-effect transistors
Appl. Phys. Lett., 85 (2004) 5078-5080.
3. T. Kanbara, T. Iwasa, K. Tsukagoshi, Y. Aoyagi, and Y. Iwasa
Gate-induced crossover from unconventional metals to Fermi liquids in multiwalled carbon nanotubes.
Appl. Phys. Lett., 85 (2004) 6404-6406.
4. H. Shimotani, G. Diguët, and Y. Iwasa
Direct comparison of field-effect and electrochemical doping in regioregular poly(3-hexylthiophene).

Appl. Phys. Lett. 86 (2005) 022104-1-3.

5. A. Maeda, S. Matsumoto, H. Kishida, T. Takenobu, Y. Iwasa, M. Shiraishi, M. Ata, and H. Okamoto
Large optical nonlinearity of semiconducting single-walled carbon nanotubes under resonant excitations
Phys. Rev. Lett. 94 (2005) 047404-1-4.

【Plan】

The aim of this group is to make novel functional materials and devices using nanostructured carbons, organic materials, and related systems. In the coming years, we are going to focus on the following three directions.

- (1) Physics of organic electronics
- (2) Properties of purified and composite carbon nanotubes
- (3) Carrier doping of Van der Waals solids and search for novel electronic states.