November 25, 2009.

Japan Science and Technology Agency (JST)
Tel:03-5214-8404

AIMR, Tohoku University
Tel:022-217-4977

Electric field control of two-dimensional electrons in polymer-gated oxide semiconductor heterostructures

The research group of Prof. Kawasaki in WPI-AIMR has successfully demonstrated the systematic control of two-dimensional (2D) electron transport at oxide heterointerfaces using Schottky-gating via conducting polymer, PEDOT:PSS (poly(3,4-ethylenedioxythiophene): poly(styrenesulfonate)). PEDOT:PSS works excellent Schottky contact electrode on oxide semiconductor ZnO because of clean organic-inorganic interface with abruptness both in crystallographic and electronic properties. In this study, a field-effect transistor shown in Fig. 1 was fabricated by conventional molecular-beam epitaxy for MgZnO/ZnO heterostructures and spin coating for PEDOT:PSS. 2D electron density and conductivity were systematically tuned by the application of gate bias voltage at 2 K. In addition, we found interesting physical phenomenon of insulator-to-metal transition at a certain gate bias as shown in Fig. 3. These achievements pave a way for harmless, transparent, and low cost field-effect transistors. This work was performed for a sample supplied from ROHM Co. Ltd. These results will be published in Advanced Materials at November 25th, 2009.

＜Title and authors＞

“Electric field control of two-dimensional electrons in polymer-gated oxide semiconductor heterostructures”
Masaki Nakano, Atsushi Tsukazaki, Akira Ohtomo, Kazunori Ueno, Shunsuke Akasaka, Hiroyuki Yuji, Ken Nakahara, Tomoteru Fukumura, and Masashi Kawasaki
Advanced Materials, in press.

[Contact about the research]
Professor Masashi Kawasaki
WPI Advanced Institute for Materials Research (WPI-AIMR,) Tohoku University
Address: 2-1-1 Katahira, Aoba-ku, Sendai, 980-8577, Japan
TEL: +81-22-215-2085, FAX: +81-22-215-2086
E-mail: kawasaki@imr.tohoku.ac.jp

< Figures >

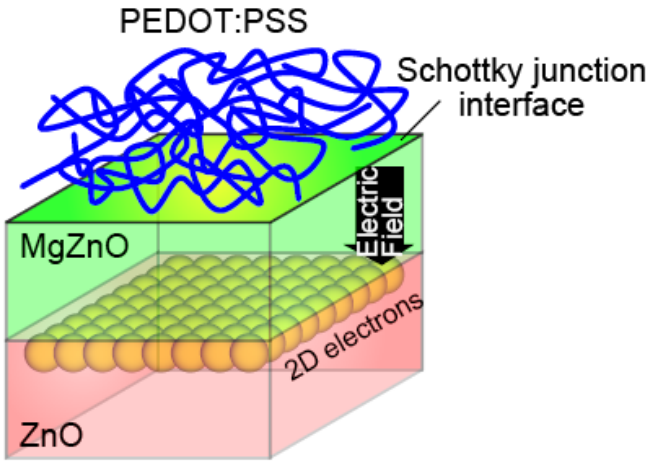

Fig. 1 Simple cross-sectional illustration of the field-effect transistor device.

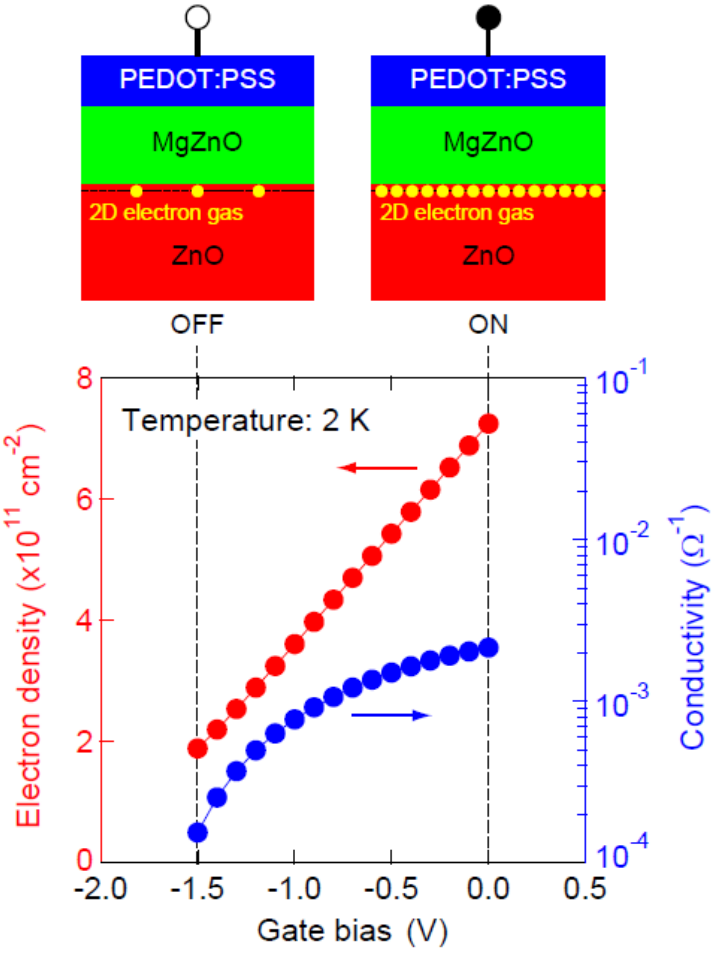

Fig. 2 Electron density and conductivity as a function of gate bias.

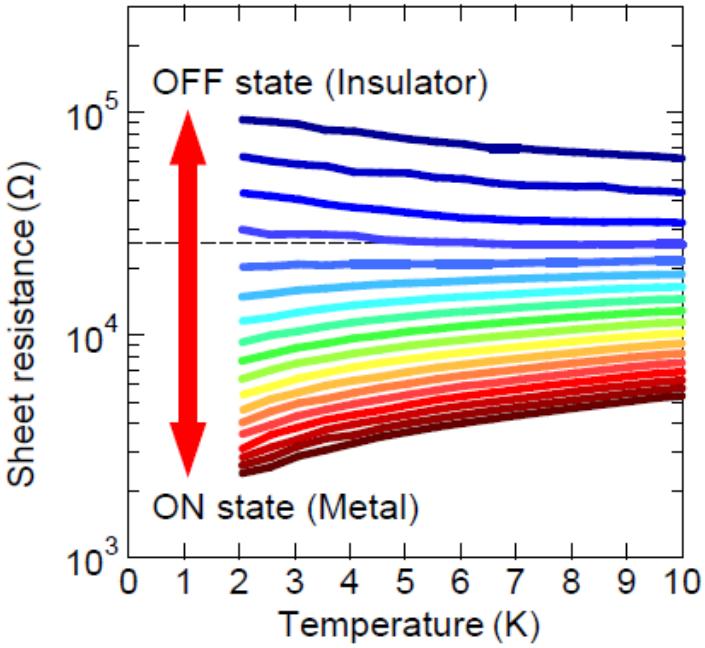

Fig. 3 Insulator-to-metal transition tuned by gate bias voltage.