Solution grown ZnO Nanowire Films for Bipolar Transistors

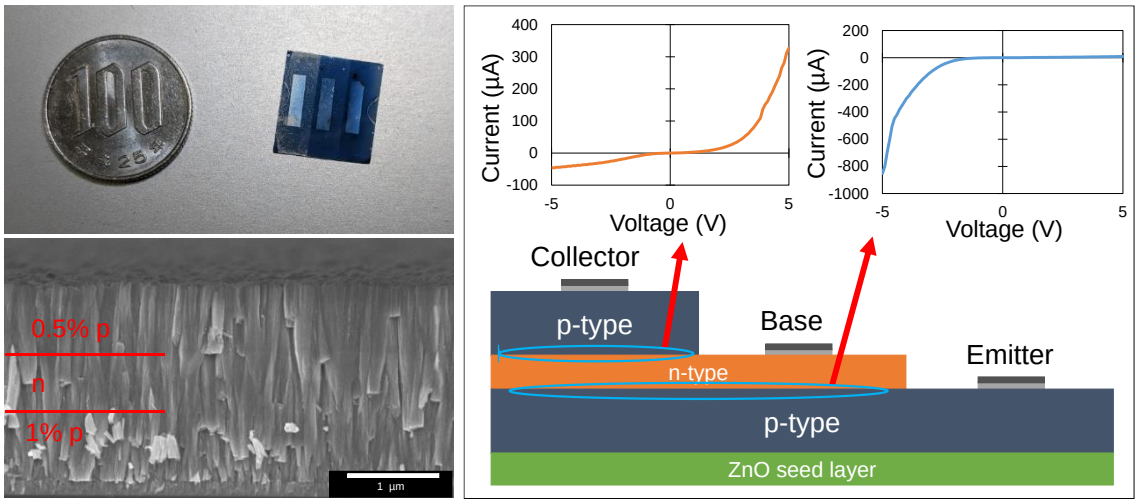
Ken C. Pradel (Presenter)[1], Yunfang Wang[1,2], and Naoki Fukata[1]

[1]International Center for Materials Nanoarchitectonics (MANA), National Institute for Materials Science (NIMS)

[2]Institute of Applied Physics, University of Tsukuba

E-mail: Pradel.ken@nims.go.jp

Zinc oxide has always been a popular material in research due to its optoelectronic and piezoelectric properties. However, the lack of a stable p-type dopant has always limited its broader applicability. Recent research has found that antimony can be used to produce stable p-type ZnO nanowires, with p-type behavior maintained for well over 18 months. Further work showed that these wires could be coalesced and grown into films, forming p-n junctions that were used in both optoelectronic and piezoelectric devices. However, in all this work, the primary conduction pathway was along the length of the nanowire, as even though the wire density was quite high, there are still a large number of gaps between the wires which limits the number of conductive pathways. To expand the applications of this new material, an optimized growth and annealing process was developed in order to remove the interfacial defects between the wires, thus improving lateral conductivity. The primary challenge was finding a balance of nanowire diameter and annealing temperature that allowed the wires to coalesce without leading to cracking due to differences in thermal expansion between the ZnO nanowires and the underlying substrate. After achieving this, a simple PNP bipolar transistor was fabricated as a proof of concept. By starting with simple electronic components, and moving up, low cost systems based on ZnO could eventually be realized.



Reference:

(1) Wang, F. et al. An aqueous solution-based doping strategy for large-scale synthesis of Sb-doped ZnO nanowires. *Nanotechnology* **2011,** *22* (22), 225602.

(2) Pradel, K. C. et al. Solution-Derived ZnO Homojunction Nanowire Films on Wearable Substrates for Energy Conversion and Self-Powered Gesture Recognition. *Nano Letters* **2014,** *14* (12), 6897-6905.

(3) Pradel, K. C. et al. Solution derived p-ZnO/n-Si nanowire heterojunctions for photodetection. *Chemical Physics Letters* **2016,** *658*, 158-161.