Optoelectronics and Semiconductor Group
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Field of study: nanomaterials and devices, optoelectronic thin films devices, biophotonics and solar cells applications
Key words: nanowire, gas sensor, field emission, Nano Optoelectronic devices
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1. The Subject and Aims of Research

The application of nanostructure materials and optoelectronic thin films devices were mainly studied. At present, the major objects were the fabrication of high efficiency silicon nanowires solar cell, ZnO-based optoelectronic and sensing devices, carbon-based optoelectronic and sensing devices, and green energy smart windows. The applications to biophotonics and energy-efficiency photoelectron of nanostructure materials were also developed. And combine the carbon-based nanomaterials to develop the advanced nano-optoelectronic devices.

2.

(1) **Silicon nanowires-based solar cells:**

- **Si-based solar cells**
  - **Pyramid**
  - **Silicon nanowire (SiNW)**
  - **SiNW/pyramid**
- **Fabrication of SiNWs**
  - **Thermal CVD**
  - **Electroless etching**
- **Arrayed SiNWs**
  - **Solar cells**
  - **Antireflection layers**
  - **Field emission devices**

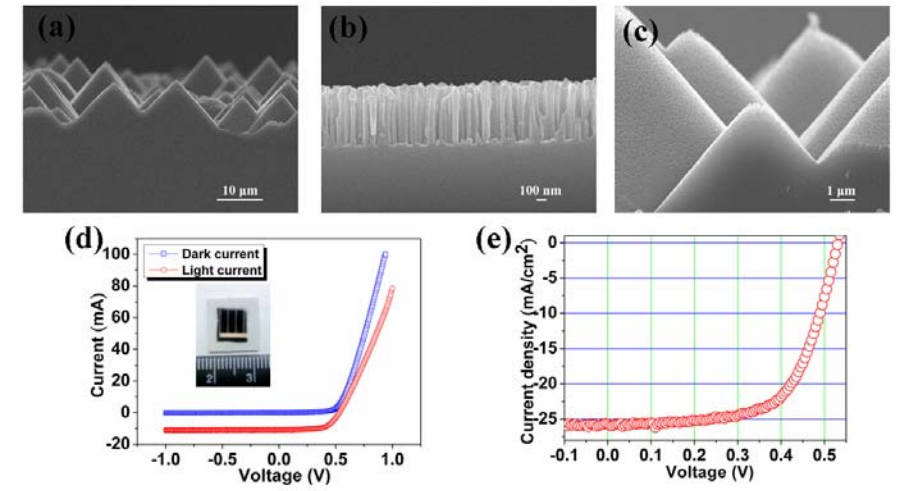

Figure 1 (a) SEM image of (a) pyramid, (b) SiNW , and (c) SiNW/pyramid. (d) I-V characteristics of SiNWs solar cell. The inset is SiNWs solar cell. (e) The light J-V curve under AM1.5G illumination.

(2) **ZnO-based optoelectronic and sensing devices:**

- **ZnO nanostructures**
  - **Nanorod / Nanotube / Nanopin**
- **Optoelectronic and sensing devices**
  - **Field emission devices**
  - **Ultraviolet photodetectors**
  - **Gas sensors**
- **Biomedical sensing devices**
  - **Alcohol sensors**
  - ***p*H sensors**

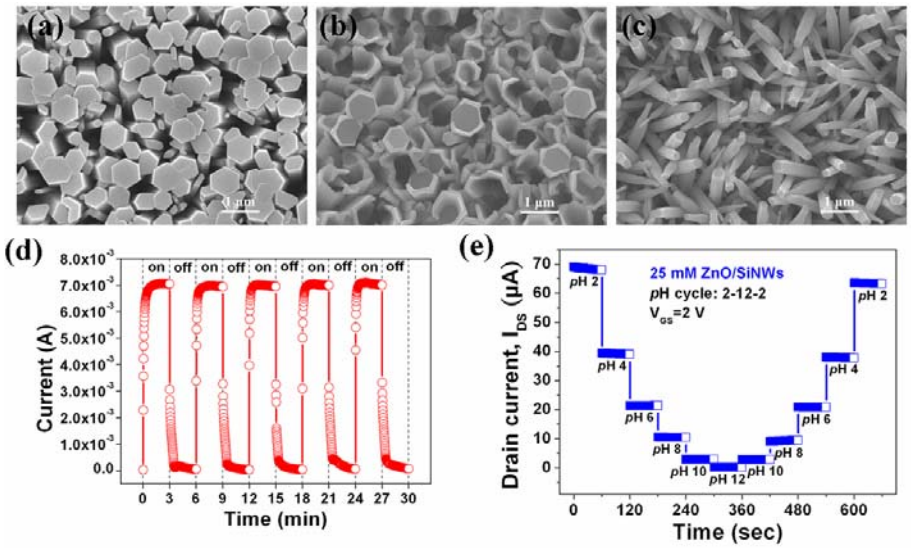

Figure 2 SEM image of (a) ZnO nanorods, (b) ZnO nanotubes, and (c) ZnO nanopins. (d) The real-time photo response at 5 V bias under 365 nm wavelength illumination. (e) Real-time I_{DS} responses to buffer solutions of 25 mM ZnO/SiNW sensors.

(3) Carbon-based optoelectronic and sensing devices:

- **Carbon-based nanomaterials**
  - **Carbon nanotubes (CNTs)**
  - **Nanodiamond films (NDFs)**
  - **Graphene films**
- **Optoelectronic and sensing devices**
  - **Field emission devices**
  - **Photo detectors**
  - **Gas sensors**
  - **Gas discharge sensors**
- **Biomedical sensing devices**
  - **Alcohol sensors**
  - ***p*H sensors**

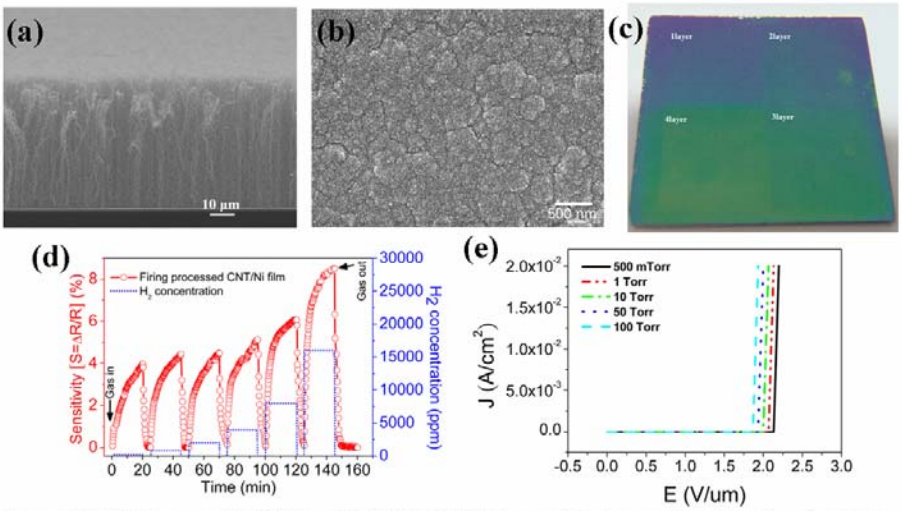

Figure 3 (a) SEM images of (a) CNTs and (b) NDFs. (c) OM image of various graphene transferred cycles on SiO_2 substrates. (c) Photo response of NCD photodetector under different wavelength light source. (d) Gas response of CNT/Ni chemical gas sensor under different H_2 concentration. (e) J-E for breakdown voltage under different pressures for H_2 gas ionization sensing.

(4) Green energy smart windows:

- **Green energy smart windows**
  - **Electrochromic devices**
  - **Gaschromic devices**
- **Functional nanowires**
  - **WO_3 nanorods**
  - **TiO_2 nanotubes**
- **Optoelectronic and sensing devices**
  - **Field emission devices**
  - **Gas sensors**

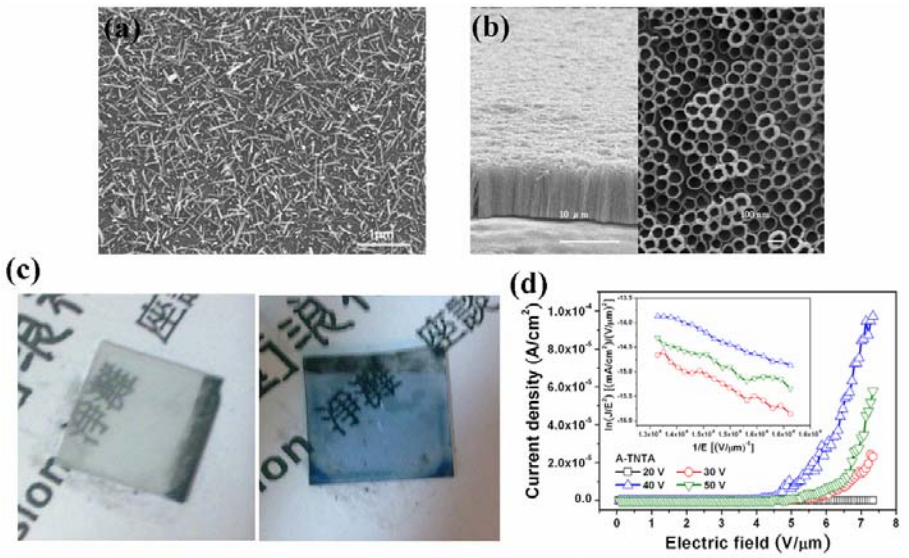

Figure 4 SEM image of (a) WO_{3-x} nanorods and (b) TiO_2 nanotibes. (c) The photograph image of bleaching mode and coloration mode. (c) SEM images of the cross and top view of ZnO nanowires, (d) J–E characteristics of aggregated TiO_2 nanotubes (A-TNTs) fabricated with various applied voltages.

3. Selected Publications and Projects

Publications:

1. **Bohr-Ran Huang**, Ying-Kan Yang, Hsien-Lung Cheng, Rice-straw-like structure of silicon nanowire arrays for a hydrogen gas sensor, accepted by *Nanotechnology*. (Impact factor: 3.842, cited: 0)
2. **Bohr-Ran Huang**, Chung-Chi Liao, Chun-Yi Lu, Wen-Cheng Ke, Yi-Lun Huang, Nai-Chuan Chen, "Reduction of angular dip width of surface plasmon resonance sensor by coupling surface plasma waves on sensing surface and inside metal–dielectric–metal structure", *Journal of Vacuum Science & Technology A*, 31 (2013) 06F104. (Impact factor:1.432, cited: 0)
3. **Bohr-Ran Huang**, Tzu-Ching Lin, Kuo-Ting Chu, Ying-Kang Yang, Jun-Cheng Lin, "Field emission properties of zinc oxide/zinc tungstate ($ZnO/ZnWO_4$)

composite nanorods", *Surface & Coating Technology*, 231 (2013) 289-292. (Impact factor:1.941, cited: 0)

4. Jun-Cheng Lin, **Bohr-Ran Huang**, Tzu-Ching Lin, "Bilayer structure of ZnO nanorod/nanodiamond film based ultraviolet photodetectors", *Journal of The Electrochemical Society*, 160(8) (2013) H509-H512. (Impact factor:2.588, cited: 0)
5. **Bohr-Ran Huang**, Jun-Cheng Lin, "A facile synthesis of ZnO nanotubes and their hydrogen sensing properties", *Applied Surface Science*, 280 (2013) 945-949. (Impact factor:2.112, cited: 0)
6. Tzu-Ching Lin, **Bohr-Ran Huang**, "Temperature effect on hydrogen response for cracked carbon nanotube/nickel (CNT/Ni) composite film with horizontally-aligned carbon nanotubes", *Sensors and Actuators B Chemical*, 185 (2013) 548-552. (Impact factor:3.535, cited: 0)
7. Jun-Cheng Lin, **Bohr-Ran Huang**, Ying-Kang Yang, "IGZO nanoparticle-modified silicon nanowires as extended-gate field-effect transistor pH sensors", *Sensors and Actuators B Chemical*, 184 (2013) 27-32. (Impact factor:3.535, cited: 0)
8. **Bohr-Ran Huang**, Jun-Cheng Lin, Ying-Kang Yang, "ZnO/Silicon Nanowire Hybrids Extended-gate Field-effect Transistors as pH Sensors", *Journal of The Electrochemical Society*, 160(6) (2013) B78-B82. (Impact factor:2.588, cited: 2)
9. Sheng-Bo Wang, Chih-Hung Hsiao, Shoou-Jinn Chang, Z. Y. Jiao, Sheng-Joue Young, Shang-Chao Hung, **Bohr-Ran Huang**, "ZnO Branched Nanowires and the p-CuO/n-ZnO Heterojunction Nanostructured Photodetector", *IEEE Transactions on Nanotechnology*, 12(2) (2013) 263-269. (Impact factor: 1.8, cited: 0)
10. **Bohr-Ran Huang**, Ying-Kang Yang, Wen-Luh Yang, "Key Technique for Texturing a Uniform Pyramid Structure with a Layer of silicon nitride on Monocrystalline Silicon Wafer", *Applied Surface Science*, 266 (2013) 245-249 (Impact factor:2.112, cited: 0)
11. Yunyun Zhang, Xiaowei Sun, Wen-Yu Kuo, Liann-Be Chang, **Bohr-Ran Huang**, Junliang Zhao, Haitao Dai, Shuguo Wang, "Optimization of the Au Stud Bump Number for the Flip-Chip Packaged InGaN LEDs", *Advanced Materials Research Vols.*, 753-755 (2013) 2515-2520 (EI)
12. **Bohr-Ran Huang**, Jun-Cheng Lin, "Core-shell structure of zinc oxide/indium oxide nanorod based hydrogen sensors", *Sensors and Actuators B Chemical*, 174 (2012) 389-393 (Impact factor:3.535, cited: 4)
13. Sheng-Bo Wang, Ming-Shien Hu, Shoou Jinn Chang, Cheong-Wei Chong, Hsieh-Cheng Han, **Bohr-Ran Huang**, Li-Chyong Chen, Kuei-Hsien Chen.

"Gold nanoparticle-modulated conductivity in gold peapodded silica nanowires", *Nanoscale*, 4 (2012) 3660-3664 (Impact factor:6.233, cited: 3)

14. Tse-Pu Chen, Sheng-Joue Young, Shoou-Jinn Chang, **Bohr-Ran Huang**, Shih-Ming Wang, Chih-Hung Hsiao, San-Lein Wu, Chun-Bo Yang "Low-frequency noise characteristics of GaN schottky barrier photodetectors prepared with nickel annealing, *IEEE Sensors Journal*, 12 (2012) 2824-2829 (Impact factor:1.475, cited: 0)
15. Zhan-Shuo Hu, Fei-Yi Hung, Shoou-Jinn Chang, **Bohr-Ran Huang**, Bo-Cheng Lin, Wei-Kang Hsieh, Kuan-Jen Chen. "Effect of Ag film thickness on the crystallization mechanism and photoluminescence properties of ZnO/Ag nanoflower arrays", *Applied Surface Science*, 258 (2012) 8049-8054 (Impact factor:2.112, cited: 0)
16. N. C. Chen, C. Y. Lu, Y. L. Huang, C. C. Liao, W. C. Ke, **B. R. Huang**, "Properties of coupled surface plasmon-polaritons in metal-dielectric-metal structures", *Journal of applied physics*, 112 (2012) 033111 (Impact factor:2.21, cited: 1)
17. S. B. Wang, C. H. Hsiao, S. J. Chang, K. T. Lam, K. H. Wen, S. C. Hung, S. J. Young, S. C. Hung, **B. R. Huang**, "CuO nanowire-based humidity sensor", *IEEE Sensors Journal*, 12 (2012) 1884-1888 (Impact factor:1.475, cited: 2)
18. **Bohr-Ran Huang**, Tzu-Ching Lin, Jinn P. Chu, Yen-Chen Chen "Long-term stability of a horizontally-aligned carbon nanotube field emission cathode coated with a metallic glass thin film", *Carbon*, 50 (2012) 1619-1624 (Impact factor: 5.868, cited: 4)
19. **Bohr-Ran Huang**, Ying-Kang Yang, Tzu-Ching Lin, Wen-Luh Yang, "A simple and low-cost technique for silicon nanowire arrays based solar cells", *Solar Energy Materials and Solar Cells*, 98 (2012) 357-362. (Impact factor: 4.63, cited: 13)
20. T. P. Chen, S. J. Young, S. J. Chang, S. M. Wang, C. H. Hsiao, **B. R. Huang**, C. B. Yang, "Effect of Nickel Annealing on GaN-Based Photodetectors", *Electrochemical and Solid State Letters*, 15(4) (2012) H111-H114 (Impact factor:2.01, cited: 0)
21. Tzu-Ching Lin, **Bohr-Ran Huang**, "Palladium Nanoparticles Modified Carbon Nanotube/Nickel Composite Rods (Pd/CNT/Ni) for Hydrogen Sensing", *Sensors and Actuators B Chemical*, 495 (2012) 108-113 (Impact factor:3.535, cited: 3)
22. **Bohr-Ran Huang**, Ying-Kan Yang, Tzu-Ching Lin, Wen-Luh Yang, "Core-shell structure of a silicon nanorod/carbon nanotube field emission cathode", *Journal of Nanomaterials*, (2012) Article ID 369763 (Impact factor: 1.547, cited: 1)

Patents:

1. A METHOD FOR MASS PRODUCTION OF SILICON NANOWIRES, TWI 246541, 2006.

2. STRATIFIED SUBSTRATE STRUCTURE AND METHOD FOR PRODUCING NANOWIRES USING THE SAME, TWI 265047, 2006.

3. METHOD OF MANUFACTURING ANTI-COUNTERFEIT INK AND ANTI-COUNTERFEIT TAG AND METHOD OF MANUFACTURING THE SAME, TWI 398495, 2013.

Projects:

(1) 99/8/1~100/7/31, Fabrication of Arrayed Carbon nanotube Flexible Optoelectronic Devices using Metallic Glass Technologies, National Science Council of the Republic of China.

(2) 100/8/1~103/7/31**,** The development of a novel nano-composite plating technique for multifunctional optoelectronic sensing devices, National Science Council of the Republic of China.

(3) 101/11/1~102/10/31, The development for mutifunctional sensing devices of nano carbon composite materials with low temperature deposition process, National Science Council of the Republic of China.