Presentation for Bachelor's Project (PHC401)

Use of Ga_2O_3 / ZnO heterostructure for fabricating enhanced UV photodetectors

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Applications of UV photodetectors

- Deep Space Communication
- High-Speed Data Transfer
- Protein analysis
- DNA sequencing
- Sterilization and Disinfection
- UV Imaging
- Flame sensing and fire alarm systems
- Monitoring Air pollution and Ozone levels
- Missile plume detection

Fabrication of UV photodetectors

- Fabrication of ZnO thin film using sol-gel spin coating method
- Growth of ZnO nanorods using hydrothermal method
- Growth of GaOOH nanorod arrays using hydrothermal method
- Conversion of GaOOH nanorod arrays to β-Ga_2O_3 nanorod arrays

Fabrication of ZnO thin film using sol-gel spin coating method

- **Zinc acetate dihydrate was dissolved in a mixture of 2-methoxyethanol (solvent) and monoethanolamine (stabilizer)**

- **Solution was aged for 24 hrs at room temperature**

Fabrication of ZnO thin film using sol-gel spin coating method

- **Clean glass substrates were spin-coated using the above solution at 3000 rpm for 30 sec**
- **The process of spin coating was repeated 5 times on each substrate**
- **Grown film was annealed in air at 550^{o}C for 1 hr**
- **This resulted in ZnO seed layer**

Growth of ZnO Nanorods using hydrothermal method

- Aqueous solution of zinc nitrate hexahydrate ($Zn(NO_3)_2.6H_2O$) and hexamethylenetetramine ($C_6H_{12}N_4$) was prepared
- ZnO seed layer was suspended upside down in the above solution
- The entire system was kept in oven at 90^oC for 10 hrs
- This resulted in hydrothermal growth of ZnO nanorods

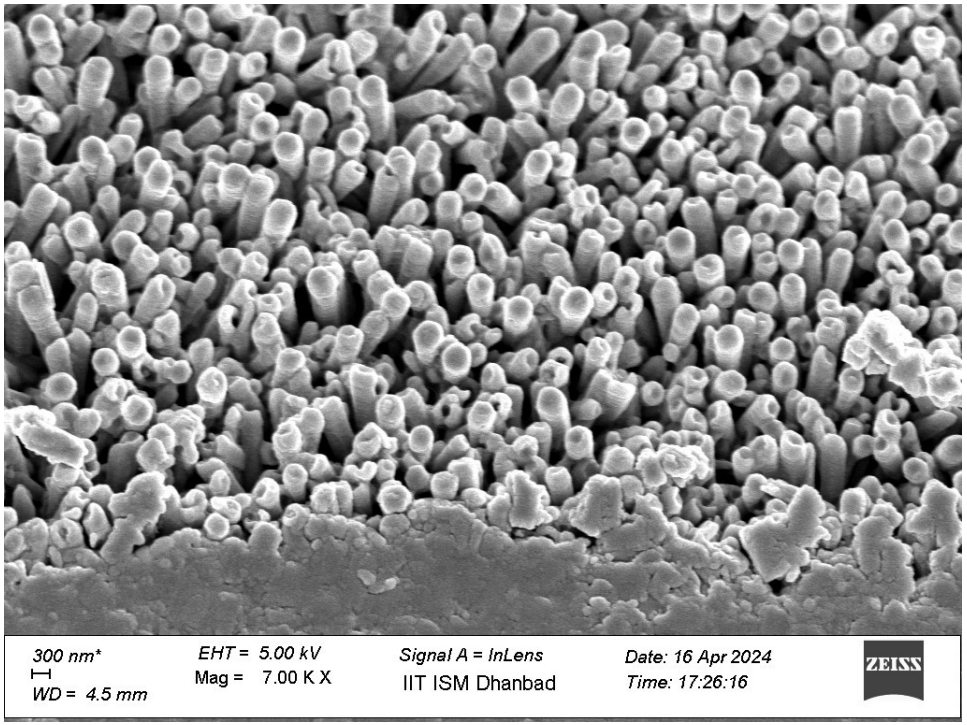
Growth of β-Ga2O3 nanorod arrays

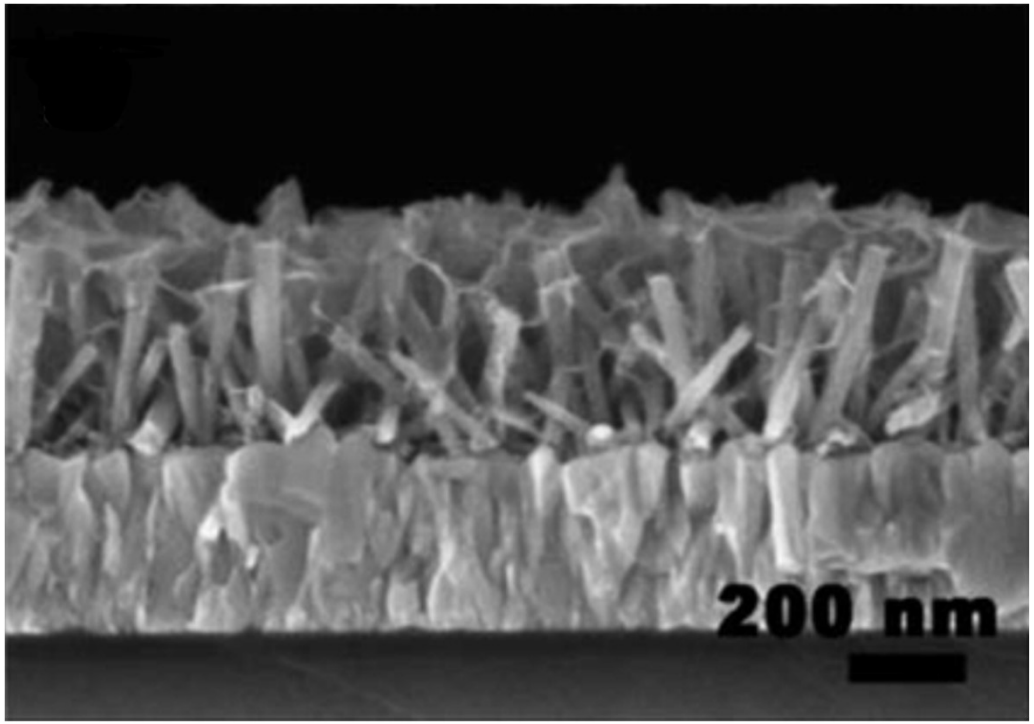
- ZnO nanorod arrays were placed in $Ga(NO_3)_3.9H_2O$ and heated at 150^oC for 10hrs
- This resulted in growth of GaOOH nanorod arrays
- GaOOH nanorod arrays were annealed at 500^oC for 30 mins
- This resulted in conversion of GaOOH nanorod arrays to β-Ga_2O_3 Nanorod arrays

Advantage of use of ZnO nanorods and β-Ga2O3 nanorods

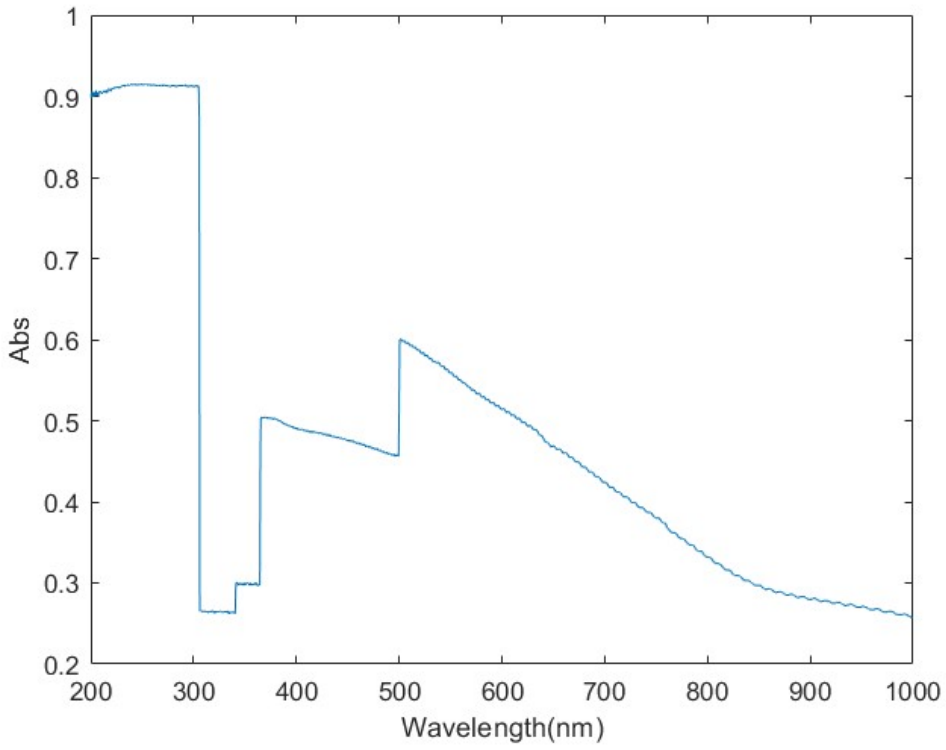
- Large bandgap of ZnO and Ga_2O_3 corresponding to UV wavelength
- High exciton binding energy of ZnO
- Heterojunction acts as a better photodetector as compared to normal photodetectors due to built-in electric field

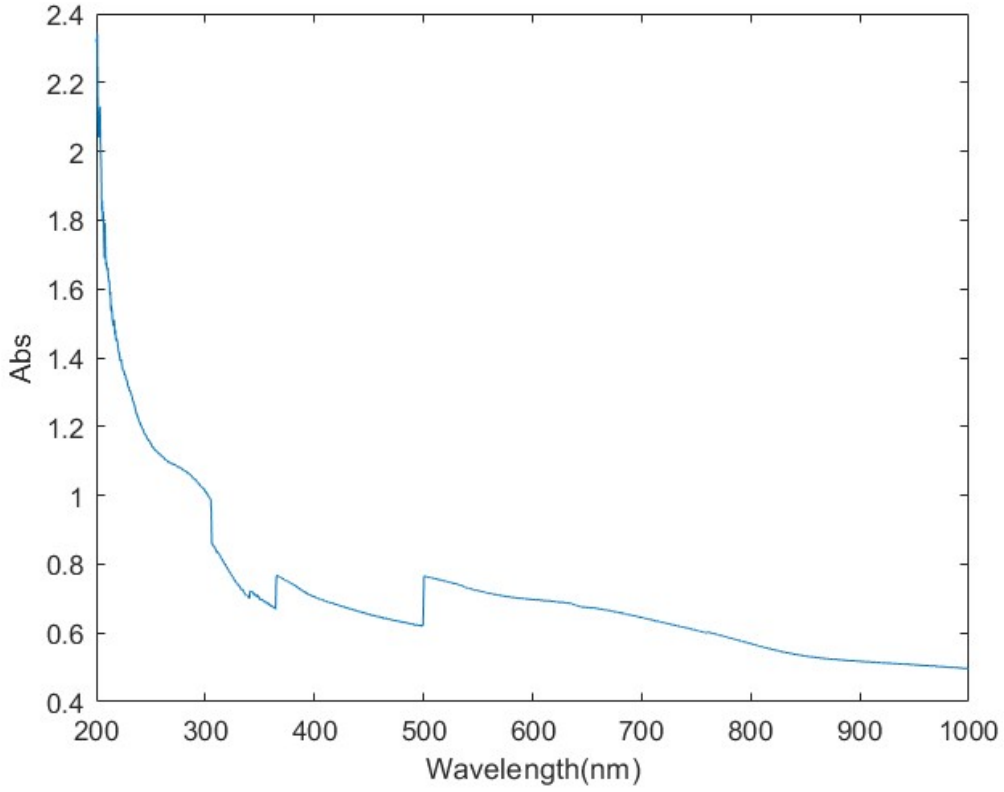
FESEM


300 nm*
WD = 4.5 mm
EHT = 5.00 kV
Mag = 7.00 K X
Signal A = InLens
IIT ISM Dhanbad
Date: 16 Apr 2024
Time: 17:26:16
ZEISS

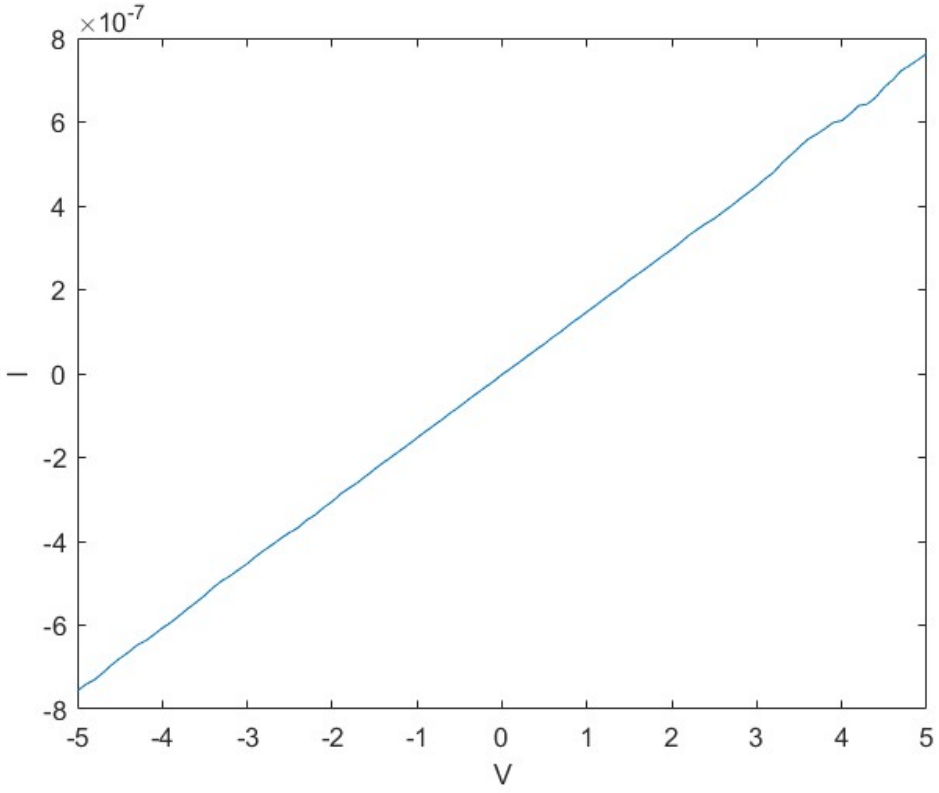

200 nm

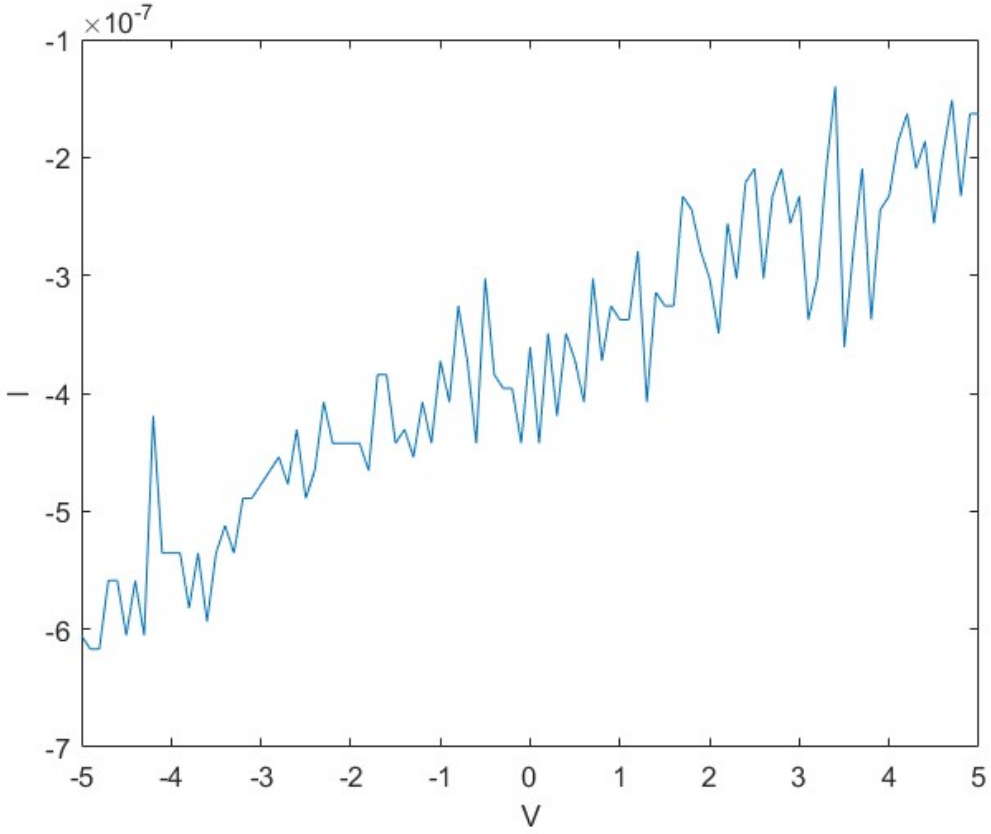
UV Spectroscopy





I-V Characteristic Graph





Conclusion

- **Formation of heterojunction between ZnO and Ga_2O_3**
- **UV absorption of Ga2O3 / ZnO heterostructure is much higher than when using only ZnO nanorods**
- **I-V Characteristic of both ZnO and Ga2O3 / ZnO heterostructure show that they behave like insulators with high bandgap**

Conclusion

THANK YOU !!