# CHARACTERIZATION OF ELECTRONIC PROPERTIES OF ZnO NANORODS BY SCANNING PROBE MICROSCOPIES

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## 1 INTRODUCTION

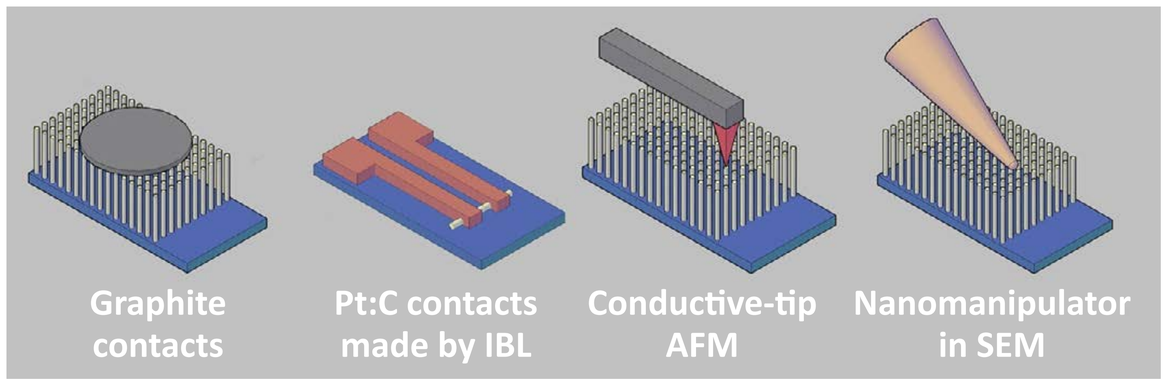
Semiconductor one-dimensional nanostructures possess a vast number of remarkable physical and chemical properties thanks to their high aspect ratio at nanoscale dimensions.

ZnO is a wide bandgap semiconductor with a series of unique properties: a large exciton binding energy, good optical transmittance in the optical region, piezoelectricity, solid mechanical stability and a high level of biocompatibility. These properties allow for applications of ZnO in UV light-emitting devices and detectors, field-effect transistors, solar cells, piezoelectric nanogenerators, or chemical sensors.

Transitioning from bulk to nanoscale in any application requires understanding the electric charge transport mechanisms taking place in the nanostructures.

## 2 MOTIVATION

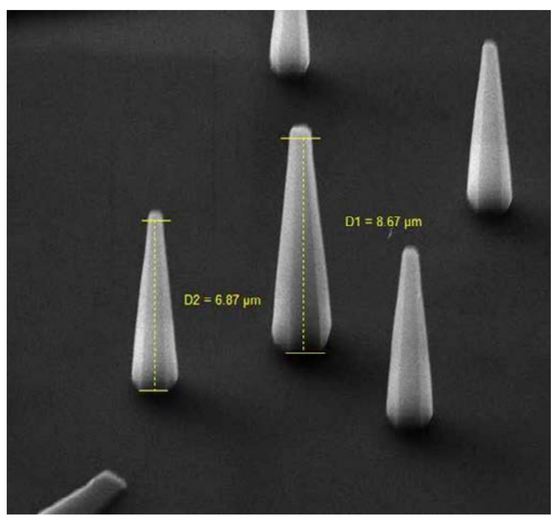
Study of electric charge transport in one-dimensional ZnO nanorod arrays using various types of electrical contacts. Correlation of the transport properties with growth parameters and further electrical, optical, and structural characterization.

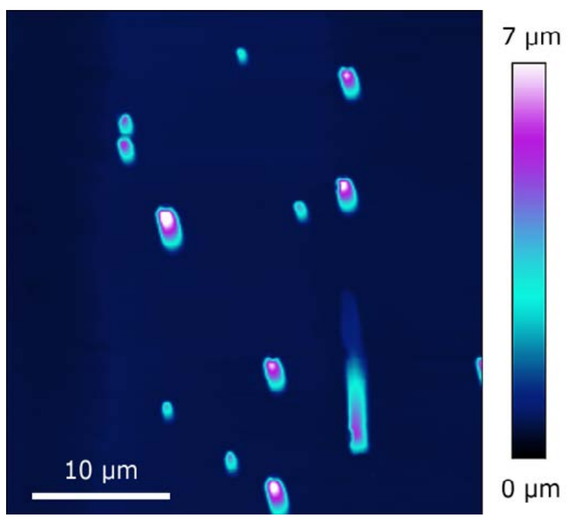



## 3 EXPERIMENTAL SETUP

Growth of the nanorods was carried out on a p-GaN template (GaN/$Al_2O_3$/Si), as this configuration allows for a reasonable price while keeping closely matching lattice constants.

Hydrothermally grown nanorods were studied in the SEM in order to locate suitable areas of the sample. An AFM instrument was then set to scan the location, to find a specific nanorod and to zoom in on the top facet. Scanning was then interrupted in order to obtain current-voltage measurements through the secondary circuit using custom made software and hardware to allow for precise measurements.




## 4 RESULTS

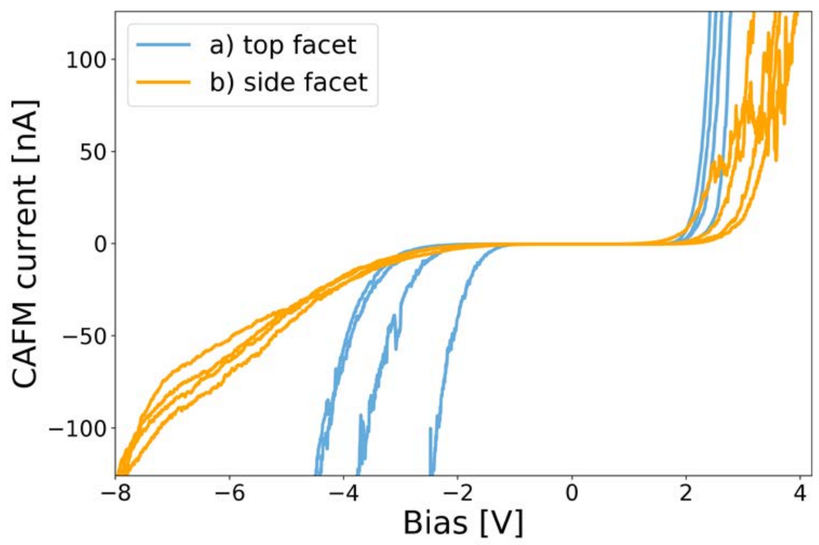
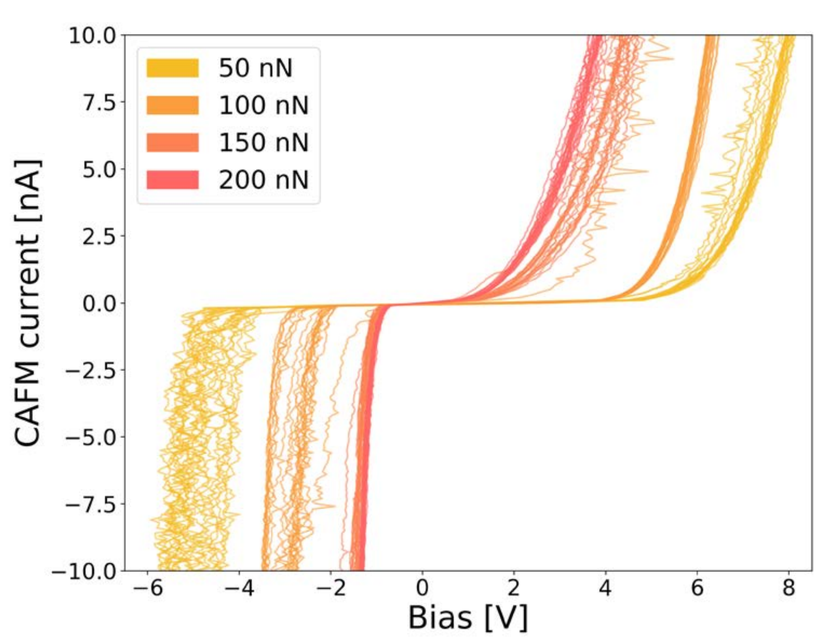



**Figure 1.** Dependence of I-V curve shape on the contacted facet in configurations **a)** and **b)**.



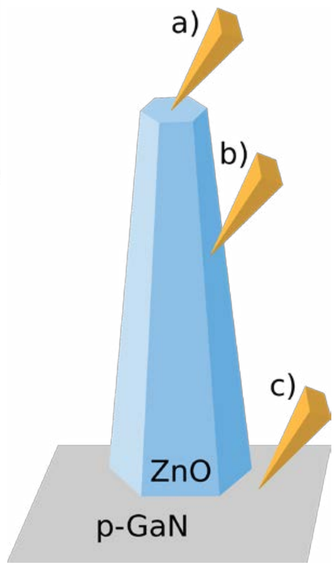
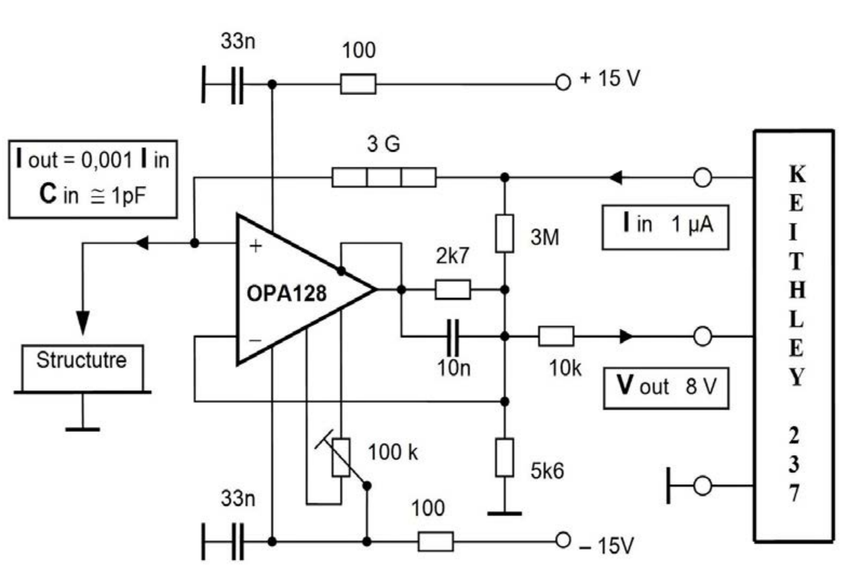
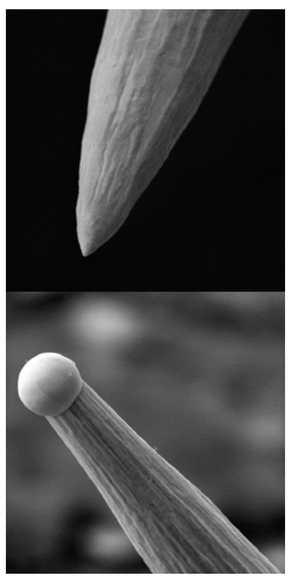




**Figure 2.** Dependence of I-V curve stretch on the AFM tip force. All curves in configuration **c)**.

## CUSTOM ELECTRONICS

Measurements were carried out in air at ambient conditions using solid Pt cantilevers RMN-25PT300B and RMN-12PT400B. In-house developed "Low Input Capacity Current Adapter" enables low current measurements and provides current overload protection for the cantilever.



## 5 CONCLUSIONS

- In-house electronics and software for low input current measurements were developed and successfully tested.
- Current-voltage characteristics of ZnO nanorods and different GaN substrates were carried out using CAFM.
- Electronic properties of both nanorods and substrates have been observed to depend on AFM tip force.
- Measured I-V curves have been observed to depend on the contacted facet.

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