NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2022-2023

Nanoscale probing piezoelectricity in semiconductor Nitride nanowires

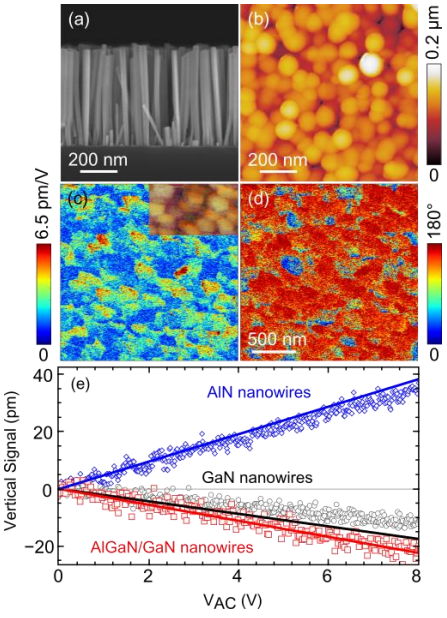
General Scope:

In the last decades, the field of electronics has further moved toward personal, portable, and flexible devices with multi-functional, smart, and self-powered systems. This direction needs interactions between electronics and human activities, which are related to mechanical actions. Piezoelectric semiconductor nanowires such as ZnO or GaN nanowires were suggested as a promising building block for nanogenerators and smart self-powered sensors because of their coexisting high mechanical flexibility, piezoelectric, and semiconductor properties. This characteristic allows the mechanical manipulation of charge carriers in electronic devices which is interesting for smart systems that have increasingly required multifunctionalities. Furthermore, their inherent flexibility and stretchability offer integration with soft surfaces relevant for biomedical, wearable, and human interactive applications.

The mainstream research in this field dedicates its interest to large-scale device fabrications and optimizations. A large number of publications demonstrate nanowire piezo-harvester prototypes, focusing mainly on the electrical amplitude output of the devices. In contrast, fewer experiments have explored the piezoelectric properties of the nanowires at a local scale, which should provide insight into the parameters that play a critical role in charge generation in piezoelectric semiconductors.

Research topic and facilities available:

We will apply different scanning force microscopy (SFM) techniques such as Kelvin Probe Force microscopy (KPFM), Piezoresponse Force Microscopy (PFM), and conductive-AFM to investigate piezoelectric properties of semiconductor III-Nitrides at the nanoscale. The effect of various semiconducting properties on the piezo response from the nanowires will be studied such as surface states, surface charges caused by adsorbates, free charges induced by dopants, and encapsulation matrix. The local probing results will be correlated with the electrical and electromechanical properties of large-scale nanowire piezo harvesters. This work should give a better understanding and a further improvement of nanowire piezo harvesters.



The experiments will be performed at Néel and CERMAV in Grenoble. He/She will have an opportunity to access the AFM platform of both laboratories including the facilities for electrical, structural, and optical characterizations. The samples can be processed by using clean room facilities in NanoFab at Néel.

Possible collaboration and networking: NPSC/ Néel, CERMAV**,** ICMG

Possible extension as a Ph.D.: No funding is currently available, but we support the grant applications.

Required skills: Nanofabrications, Semiconductors, Nanomaterials, Solid State Physics

Starting date: February/March 2023 for 4 to 6 months

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Reference

L. Jaloustre, S. Le Denmat, T. Auzelle, M. Azadmand, L. Geelhaar, F. Dahlem, and R. Songmuang, ACS Appl. Nano Mater.4, 43 (2021).