2023-2026

PhD Thesis at LMGP and I NEEL

Piezoelectric ZnO Nanowires for Ambient Mechanical Energy Harvesting

Detailed Topic

The need for diversifying energy sources is a strong driving force for developing original solutions in order to harvest the ambient mechanical energy in the environment (i.e. vibrations from different sources). In this context, semiconducting materials in the form of nanowires constitute a promising building block for the fabrication of innovative devices. The nanowires typically exhibit diameters of several tens of nanometers along with a length of around one micrometer. Thanks to that geometry, they generally present an excellent crystalline quality and benefit from remarkable physical properties that are related to their high surface/volume ratio. Zinc oxide (ZnO) as a biocompatible semiconductor composed of abundant elements specifically has numerous assets and can be grown in the form of nanowires by a large number of deposition techniques. Owing to its wurtzite crystalline structure, ZnO nanowires grow along the piezoelectric *c*-axis. Vertically aligned ZnO nanowire arrays are thus sensitive to mechanical constraints and are liable to be integrated into piezoelectric nano-generators aiming at harvesting with a good efficiency the mechanical energy in the environment and hence playing the role of an energy micro-source.

The objective of the PhD thesis will consist in developing ZnO nanowire arrays with an excellent and controlled structural uniformity in terms of dimensions (i.e. diameter, length, density, period) using a low-cost, low-temperature, chemical deposition technique with a low environmental impact and a high industrial potential. Advanced structural and electro-optical characterization techniques will be used to show the morphological properties and those related to the doping and surfaces of these nanowires (i.e. electron microscopy, X-ray photoelectron spectroscopy, Raman spectroscopy, electrical and optical measurements on single nanowires, …). Finally, the fabrication of piezoelectric nano-generators based on these nanowires will be considered along with the typical associated characterization techniques.

Location & Duration

The candidate will work in the Materials and Physical Engineering Laboratory (LMGP), in the Nanomaterials and Advanced Heterostructures team (NanoMAT), as well as in Institut Néel, in the Wide Band Gap Semiconductor team (SC2G).

Web sites: http://www.lmgp.grenoble-inp.fr/ and https://neel.cnrs.fr/

Profile & Required Skills

The applicant should be an Engineering School or Master 2 student in the fields of materials physics & chemistry, nanosciences and/or semiconductor physics. Specific skills for teamwork and oral and written English expression will be appreciated. We are looking for dynamic and highly motivated candidates.

PhD Thesis Funding: The funding is available *via* the ANR project IMINEN (2023 – 2026) gathering LMGP, Institut Néel, LTM, and CEA-LETI in Grenoble with LGEF in Lyon.

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