Resistant and flexible GaN radiation sensors

Proposers

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Introduction

In the last two decades, III-nitride wide bandgap semiconductors celebrated an overwhelming success as base material for the blue light emitting diode and the blue laser used in lighting applications and the new data storage format Blu-ray. GaN and related materials are now considered the semiconductor of choice for the next generation of high power and high frequency electronics. Due to its high radiation resistance as well as thermal and chemical stability, GaN is furthermore an interesting material for electronics working in harsh environments such as space, accelerators and nuclear reactors. The high stability of GaN has triggered the research for resistant radiation detectors. However, high dislocation densities in conventional thin film technology deteriorate their performance and long term stability. In this project, the integration of GaN nano- and microwires in sensor devices will take advantage of the high crystalline quality of these structures and it will allow the fabrication of such devices on flexible substrates.

Partner 1 Specialty

The INESC-MN team has considerable expertise in semiconductor characterization, processing and microfabrication. Team members have many years of experience in studying radiation effects in GaN and other wide bandgap semiconductors and recently fabricated the first particle detection device based on a single GaN microwire.

Partner 2 Specialty

The INESC-ID group will contribute with its sound knowledge on device integration. The most promising sensors will be combined with front-end electronics for signal amplification and shaping.

Project outline/goal

The development, test and integration of the envisaged radiation sensors will follow the following steps:

i) Single wire devices will be processed by lithography techniques and various geometries will be tested, namely, axial and core-shell p-n junctions as well as metal-semiconductor-metal devices with ohmic and Schottky contacts. Besides studying performance parameters such as gain and response time, the effect of radiation damage on the electro-optical properties will be investigated.

ii) Ensembles of vertically aligned wires will be embedded in spin-on glass or PDMS matrixes and then contacted allowing an easier upgrade for industrial production as well as the integration in a flexible device.

ii) Devices will be tested in different radiation environments, namely, UV-radiation, X-rays, gamma-rays as well as energetic particles. Charge collection efficiencies will be determined and compared to conventional thin film technology.

iii) The most promising devices will be integrated in a full detector set-up.

Student profile

Profile sought: preference, but not limited, to students with a background in physics, materials science and electrical engineering.