Thin-film silicon nanoelectromechanical systems (NEMS) for sensing

Proposers

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Introduction

The Thin-Film MEMS and BioMEMS group at INESC MN (www.inesc-mn.pt) has developed a low-temperature, large-area process for the fabrication of thin-film silicon-based MEMS resonators that allows these resonators to be implemented on glass and flexible polymeric substrates, as well as integrated with CMOS in a backend process. MEMS resonators can be used as mass sensors with high sensitivities. These sensors have a wide range of potential applications. The mass sensitivity scales with the resonator frequency. To increase the frequency, either a stiffer resonator is engineered (but this creates hurdles in the actuation and sensing of the resonator motion) or a smaller resonator is microfabricated. This project aims at exploring the nanofabrication, characterization, and application of thin-film silicon NEMS.

Partner 1

The Thin-Film MEMS and BioMEMS group at INESC MN (www.inesc-mn.pt) studies microsystems that integrate silicon thin-films in either MEMS or microfluidics.

Partner 2

The Microfabrication and Exploratory Nanotechnology group of INL (inl.int) has deep expertise in integration of technologies, combining MEMS/NEMS, flexible devices, sensors, semiconductors and magnetic detectors, graphene and microfluidic features into unique systems.

Project outline/goal

The first part of the project will consist on the development of the nanofabrication process to achieve thin-film silicon nano-ressonators. This will involve the use of e-beam lithography to reach submicron lateral dimensions and fine tuning of the etching processes of electrodes, sacrificial layer, and structural layers. The emphasis will be on flexural resonators (bridges, cantilevers, and membranes.

The second part of the project will consist in simulating and experimentally characterizing the electromechanical properties of the nano-resonators. Both optical and electronic detection of the resonator motion will be used. The electromechanical properties (such as resonant frequency, quality factor, motional resistance, and frequency and phase noise) will be assessed to evaluate the possibility of integrating the MEMS as the frequency-setting element in an oscillator.

The third part of this project is to use the nano-ressonator as the mass sensor in a sensing system and benchmark its performance in terms of sensitivity against a similar, micron-sized

resonator. This performance will be modeled in terms of the electromechanical properties of the nano-resonator.

Student profile

Preference, but not limited, to students with a background in Materials Science and Engineering or Physics with an interest in Electronics or Electrical Engineers with an interest in Physics, Devices, and Micro and Nanofabrication.