From Micro and Nano Technologies to Internet of Nanoscale Things (IoNT)

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Abstract

The Internet of Nanoscale Things (IoNT) is a new network paradigm advanced from the idea of IoT, where micro and nano devices are connected each other and micro and nano technologies can play a key role for further development. The aim of this presentation to show my research interests in the IoT/IoNT based on my recent activities on micro and nanotechnologies including nanoelectromechanical (NEM) and 2D material devices so that possible collaboration opportunities to contribute to the IoT/IoNT will be explored.

Micro & Nano Technologies

Various types of micro- and nanoscale devices and technologies have been developed. Here I would like to introduce some of my recent works on (a) Nanoelectromechanical systems (NEMS) and (b) 2D material devices that could be associated with future IoT/IoNT applications.

Nanoelectromechanical systems (NEMS)

Silicon nanoscale resonators have been fabricated and charactereised towards ultrasensitive mass detectors [2-5]. A zeptogram (= 10^{-21} g) mass responsivity has been predicted [2] and the resonance frequency of 330 MHz achieved [5].

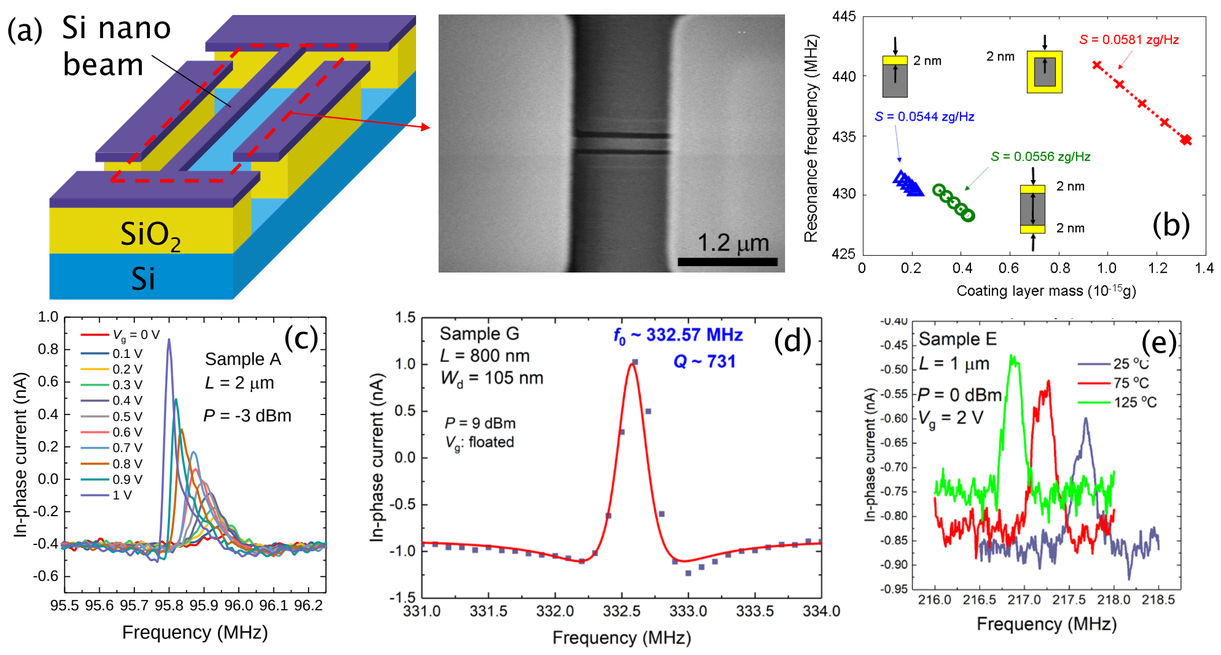

Figure 2: NEMS resonators: (a) Structure, (b) Mass responsivity simulation, (c) Nonlinear resonance in high activation voltage, (d) resonance frequency of ~ 330 MHz with L = 800 nm, and (e) temperature dependence of the resonance. [2, 5]

2D material devices

Defect-engineered atomically-thin 2D graphene devices have been fabricated and their edges and junctions have been successfully profiled by nano-Raman imaging [6, 7].

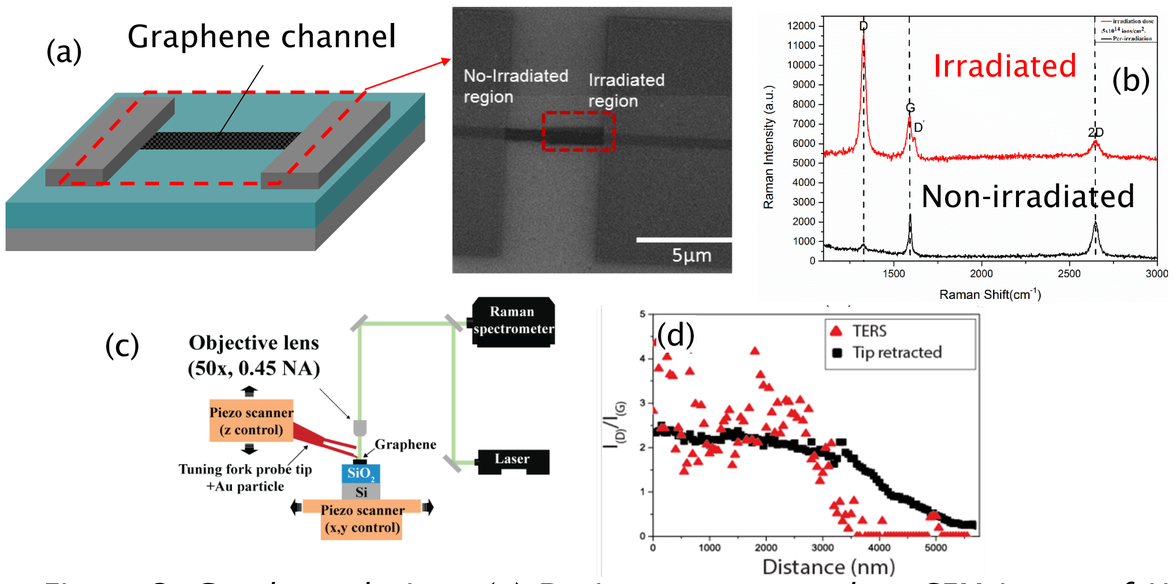

Figure 3: Graphene devices: (a) Device structure and an SEM image of He-ion-irradiated graphene channel, (b) Raman spectra of irradiated and non-irradiated graphene, (c) nano-Raman (Tip-enhanced Raman Spectroscopy, TERS) set up, and (d) defect profile across the irradiation boundary [7].

Internet of Nanoscale Things (IoNT)

Akyildiz and Jornet [1] has referred the interconnection of nanoscale devices with the Internet and existing communication networks as the Internet of Nanoscale Things (IoNT). Examples of IoNT are (1) intrabody networks and (2) interconnected office as shown below in the figure. Novel technological developments could be required for Nano-node (Nanoscale devices and circuits), Nano-router (Nanoscale communication devices), Nano-link (Nano network protocol), and Nano-micro interface.

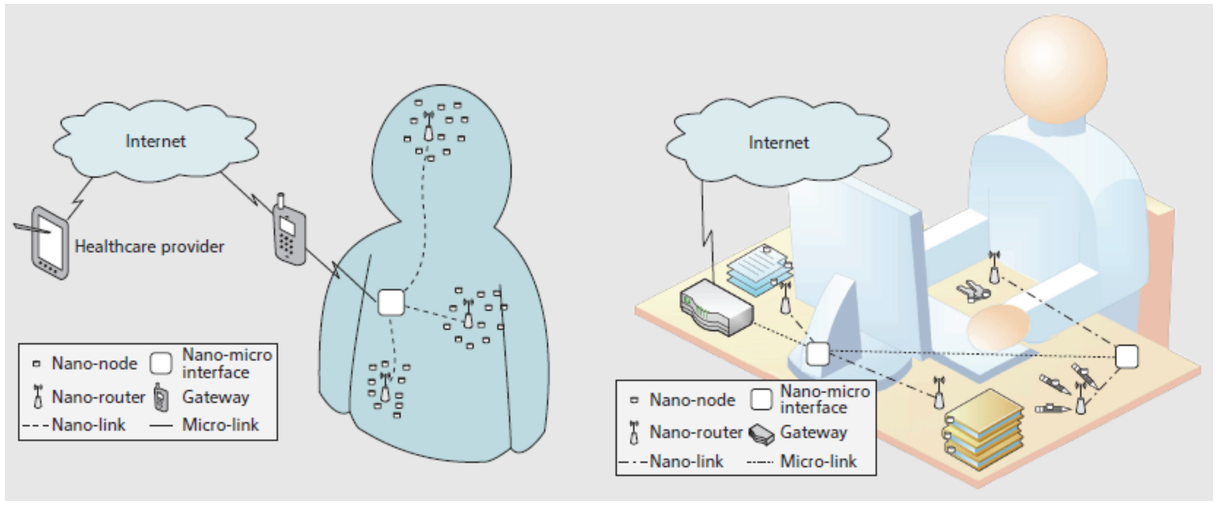

Figure 1: Schematic images of (1) Intrabody networks (left) and (2) Interconnected office (right) [1].

Research Interests

Linking of my expertise of micro and nanotechnologies with the IoT/IoNT, the following research directions primarily interest me.

(1) Development of nanoelectromechanical (NEM) signal modulators/demodulators by using silicon, carbon nanotube, or 2D materials for nano-router and nano-link applications.
(2) Design of nanoscale antennas by using 2D materials and developing integrated nanoscale circuits for nano-node, nano-router and nano-link applications.
(3) Technological development of micro and nano-interface to integrate 2D materials with wearable and implantable platform.

Note that my research interests are not limited to the topics above, but include prototyping novel architectures, quantum technologies and developing energy-efficient systems.

References

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