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Recent progress in extremely scaled electronic devices

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Presentation followed by refreshments at University Club

Venue: **Billings Room 3.04, 3rd floor. Electrical & Electronic Engineering Building**
University of Western Australia, Crawley

This seminar is open to the public and admission is free to all IEEE members and non members

Abstract

This talk will review the recent development of GaN electronics [1], graphene THz modulators [2] and tunnel field effect transistors (FETs) [3], three different topics but all are extremely scaled devices, in our group.

Current research topics on GaN electronics include high-speed transistors, power switches, and THz devices based on an NDR-gated plasmonic channel to realize THz emission, detection and amplification.

Graphene, an atomically thin 2D crystal with zero bandgap, has been touted for many intriguing applications, particularly for transparent touch screens and wearable electronics. Its optoelectronic properties are equally noteworthy. THz modulators have recently been successfully constructed using graphene for the first time, another new avenue for graphene research.

Tunnel FETs are promising replacements of Si-MOSFETs beyond 2020 due to their promise to achieve $I_{on}/I_{off} > 10^3$ with $I_{on} > 100$ μA/um at low supply voltages (up to 0.5 V). To date we have demonstrated $I_{on}/I_{off} \sim 10^6$, $I_{on} \sim 180$ μA/um, separately. Challenges ahead include electrostatic control, defect-assisted tunneling and interface state density and parasitics.

[1] a) Polarization-induced hole doping in wide-band-gap uniaxial semiconductor heterostructures. John Simon *et al. Science* 327, 60 (2010). b) InAlN/AlN/GaN HEMTs with regrown ohmics and f_T of 370 GHz. Yuanzheng Yue *et al.* IEEE Electron Device Letters, 2012. c) Power gain at THz frequencies via plasma wave excitations in HEMTs exhibiting gate negative differential conductance. Berardi Sensale-Rodriguez *et al.* 2012.

[2] a) Broadband graphene terahertz modulators enabled by intraband transitions. Berardi Sensale-Rodriguez *et al. Nature Communications*, 2012. b) Extraordinary control of terahertz beam reflectance in graphene electro-absorption modulators. Berardi Sensale-Rodriguez *et al. Nano Letters*, 2012.

[3] InGaAs/InP tunnel FETs with a subthreshold swing of 93 mV/dec and 10^6 on/off current ratio. & AlGaSb/InAs tunnel field-effect transistor with on-current of 78 uA/um at 0.5 V. G. Zhou, R. Li, A. Seabaugh and H. G. Xing *et al. IEEE Electron Device Letters, 2012.*

About the speaker:

Huili (Grace) Xing is currently the John Cardinal O'Hara CSC Associate Professor of Electrical Engineering at the University of Notre Dame. She obtained B.S. in physics from Peking University (1996), M.S. in Material Science from Lehigh University (1998) and Ph.D. in Electrical Engineering from University of California, Santa Barbara (2003), respectively. Her research focuses on development of III-V nitride and 2-D crystal semiconductor growth and optoelectronic devices, especially the interplay between the material quality and device developments. More recent research interests include THz and bioelectronic applications. She is a recipient of AFOSR Young Investigator Award and NSF CAREER Award.