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Michigan Institute for Plasma Science and Engineering

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Room 1005 EECS

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Singapore Univ. Technology & Design

Electron Emission from Two-Dimensional Novel Materials and Applications

Electron emission from a material through an interface to vacuum or other materials is a fundamental process in cathodes, diodes, ionization and electrical contact. Depending on the energy used to produce electron emission, it can be broadly characterized into 3 processes: thermionic emission TE (thermal energy), field emission FE (quantum tunneling) and photoemission PE (photon absorption or optical tunneling). Regardless of the emission mechanism, the emission current density may become saturated – space charge limited emission (SCLE). Basic models for these processes (TE, PE, PE, SCLE) have been captured in the Richardson law, Child-Langmuir (CL) law, Fowler-Nordheim (FN) law, and the Keldysh model. With the development of two-dimensional (2D) atomic scale materials, these classical laws may require revision to account for new material properties, as well as novel operating regimes in nanometer dimensions and ultrashort time scales. In this talk, self-consistent electron emission models will be presented, with applications to 2D materials such as graphene. These new models exhibit smooth transitions to the classical models while providing new scaling laws that can be included into numerical codes. These new models provide better agreement with experimental results. A selection of applications of these models to engineering product development in energy harvesting, electronics and photonics will also be presented.

About the Speaker: Lay Kee (Ricky) Ang received his BS in 1994 from National Tsing Hua Univ., Taiwan, and his MS & PhD from U. Michigan (1996, 1999). He is currently a professor under the Engineering Product Development pillar, Singapore Univ. of Technology and Design (SUTD), and the Ng Teng Fong chair Professor under the SUTD–ZJU (Zhejiang University) IDEA (Innovation, Design and Entrepreneurship Alliance). Before joining SUTD, he was with the Nanyang Technological Univ., Singapore (2002-11), and with Los Alamos National Laboratory as a postdoctoral fellow (1999-2001). His research interests are in the formulation of basic scaling laws for device physics, focusing on novel materials and nanostructures. In applied mathematics, he is applying fractional calculus to analyze complicated and disordered systems. His research is funded by Singapore (MOE, ASTAR, SUTD) and USA (AFOSR and ONRG).