**Areas of Excellence Scheme – Theory, Modeling, and Simulation of Emerging Electronics**
(AoE/P-04/08)

Layman's Summary

The remarkable miniaturization of semiconductor microelectronics over the past few decades has fundamentally shaped our everyday lives. If the miniaturization trend continues, devices are expected to reach their physical limit before year 2020. By that time, electronic devices will no longer work under the current designs, and may require conceptually different device structures and operation principles. In addition, new materials, such as low dimensional materials and spin materials, may be introduced. Because of the profound economic, social and scientific implications of the emerging technologies, intensive international research activities are underway to understand and determine the physical properties and performance characteristics of the emerging sub-22nm devices and integrated circuits.

Modeling plays a critical role in this endeavor. The existing simulation software tools for previous and present generation semiconductor devices and integrated circuits are no longer applicable to the sub-22nm technology. The main difficulty lies in the limitation of continuum models used in the current simulation tools. For the sub-22nm devices, atomic features lead to large device-to-device variability. Another difficulty is that at the sub-22nm sizes the quantum effects, which are not adequately addressed in existing simulation tools, become important. Existing simulation tools cannot account for, or even be patched up to address these effects, as they are all based on continuum models. Therefore, next generation simulation methods and software are urgently needed.

With our expertise and background in first-principles atomistic simulation methods/formulation development and continuum modeling of devices and circuits, we propose to work together and establish an Area of Excellence (AoE) in Modeling and Simulation of Emerging Electronics. Our focus will be on the modeling and simulation of sub-22nm technology. We aim to develop next generation multi-scale electronic design automation (EDA) tools that combine the atomistic simulation of individual devices, the coarse-grained modeling of integrated circuitries and simulation of electric signals propagation and interference. With these tools, we will study coherent transport through sub-22nm devices, properties of new materials and structures, lithography and new memory devices. As China is developing rapidly its electronics industry, we plan to work closely with research institutes and semiconductor companies in the region, and we expect our AoE to play an important role in this development. Through our activities and efforts, we will strive to establish Hong Kong as a world premier research centre in the modeling of emerging electronic

devices and circuitries.

** The above summary is written mainly by the project team. The views expressed in the summary do not necessarily represent those of the University Grants Committee / Research Grants Council.*