Title:

Pilot Automation for Advanced Manufacturing of High Performance Graphene Superbatteries

Research Partner:

Prof. Baohua Jia (Swinburne Melbourne)

Contact Person:

Assoc. Prof. Basil T. Wong (twong@swinburne.edu.my)

Description:

The energy crisis is impacting the social and economic development more seriously than ever before as we depleting the fossil fuels. As the only sustainable energy hope, renewable energy embarrassingly only contributes to a small portion (6%) of the world electricity generation at the moment. Part of the reason is due to the low cost-effectiveness of renewable energy, which reduces its competitiveness. But more importantly, the big mismatch of energy generation and usage makes it very challenging for renewable energy to meet the need of normal household. For example, solar electricity is most productive in the daytime. However the consumption peak arrives in the evening. If the grid is not accessible, the generated solar electricity will be render wasted. Under such a circumstance, energy storage devices are critical for renewable energy to provide stable and reliable power supply. Most of the current energy storage solutions are based on batteries, which are notorious for their toxicity and long-term hazard. Supercapacitors have been recognised as the new storage solution with high speed, minimum environmental impact and millions of life cycles. However the storage capacity is not comparable with conventional batteries. The project aims at developing the automation process on the pilot production scale for high-precision and high throughput advanced manufacturing of graphene superbatteries. The development will facilitate the industrialisation of the current superbattery technology and led to enormous industry relevant benefit.

Relevant Grant:

Pilot automation for advanced manufacturing of high performance graphene superbatteries; Baohua Jia (Principal Investigator at Hawthorn Campus), Basil T. Wong (Principal Investigator at Sarawak Campus); Sponsored by Melbourne-Sarawak Research Collaboration Scheme (MSRCS), Awarded Amounts MYR 119,000 (@Sarawak) & AUD 149,805 (@Melbourne) (2 years); 2017 - 2019.

Title:

Thermal Energy Conversion

Research Partner:

Assoc. Prof. Mathieu Franceour (University of Utah, USA)

Contact Person:

Assoc. Prof. Basil T. Wong (twong@swinburne.edu.my)

Description:

We are interested in exploring the possibility of energy conversion from heat to electricity. In doing so, we are currently looking into the application of near-field radiative heat transfer for this purpose. Near-field radiation exceeds the traditional radiation heat transfer by several orders of magnitude when the objects of interest are placed within nanometers to each other. Such a phenomenon may enable us to channel the excessive amount radiation (from high temperature object) onto the photovoltaic cells to generate electricity. Our main interest here is generally from the numerical modelling standpoint where we try to discover means of optimizing the effects and conversion efficiency.

Relevant Grant:

Development of A Novel Software for Simulating Nanoscale Electrical-Thermal Responses of Near-Field Thermophotovoltaic Cell for Sustainable Renewable Energy Conversion and Future Code Commercialization; Basil T. Wong (Principal Investigator); Sponsored by ScienceFund by Ministry of Science, Technology and Innovation (MOSTi) (Malaysia); Awarded Amount MYR 197,000 (2.5 years); June 2014 - December 2016.

Relevant Journal Publications:

Japheth Z-J Lau and Basil T. Wong, “Opto-Electro-Thermal Simulation of a Silicon Thin-Film Near-Field Thermophotovoltaic Device Coupled with a Thin-Film Tungsten Radiator," Journal of Applied Physics, 2017. (Accepted)

Japheth Z-J Lau and Basil T. Wong, “Indium Tin Oxide-Based Selective Emitter for Nano-Gap TPV Applications," submitted to Journal of Nano Research, 2017. (Accepted)

Japheth Z-J Lau, Victor N-S Bong, and Basil T. Wong, “Parametric Investigation of Nano-gap Thermophotovoltaic Energy Conversion," Journal of Quantitative Spectroscopy and Radiative Transfer, Vol. 171, 2016, pp. 39-49. (DOI: 10.1016/j.jqsrt.2015.11.023)

Basil T. Wong, Mathieu Francoeur, Victor N-S Bong, and M. Pınar Mengüç, "Coupling of Near-Field Thermal Radiative Heating and Phonon Monte Carlo Simulation: Assessment of Temperature Gradient in n-Doped Silicon Thin Film," Journal of Quantitative Spectroscopy and Radiative Transfer, Vol. 143, 2014, pp. 46-55. (DOI: 10.1016/j.jqsrt.2013.09.002)

Title:

Thermal Properties and Heat Conduction at Nanoscale

Research Partner:

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Contact Person:

Assoc. Prof. Basil T. Wong (twong@swinburne.edu.my)

Description:

The objective of this research is to explore heat transfer between electrons and phonons at the fundamental level in nanostructures with irregular shape/boundaries. We are developing simulations for electron transport and phonon transport for this application. These coupled simulations will be able to account for sophisticated electronic band structures and phonon dispersion relations as well as corresponding scattering properties, to produce insights in ballistic/semi-ballistic electron-phonon transport, and thus to predict heat distribution inside nanostructures. This is important in tackling applications in the manufacturing industry where nanostructures in devices are being actively used and heat transfer is a major concern of the design, especially in solar cells and thermophotovoltaic systems.

Relevant Grant:

Fundamental Study and Software Development For Simulating Heat Distribution Inside Nanostructures with Irregular Shapes/Boundaries; Basil T. Wong (Principal Investigator); Sponsored by Ministry of Higher Education (MOHE) – Fundamental Research Grant Scheme (FRGS) (Malaysia); Awarded Amount MYR 109,500 (3 years); September 2012 - August 2015.

Relevant Journal Publications:

Victor N-S Bong and Basil T. Wong, “The Effect of Phonon Anisotropic Scattering on the Thermal Conductivity of Silicon Thin Films at 300K and 400K,” Journal of Physics and Chemistry of Solids, Vol. 88, 2016, pp. 41-46. (DOI: 10.1016/j.jpcs.2015.09.010)

Victor N-S Bong and Basil T. Wong, "Solution of the Boltzmann Transport Equation of Phonon Transport via Speed-Up Transient Monte Carlo Method using Reference Temperature” Numerical Heat Transfer, Part B: Fundamentals, Vol. 66, Issue 3, 2014, pp. 281-306. (DOI: 10.1080/10407790.2014.901005)

Basil T. Wong, "The Impact of Internal Polarized Monochromatic Acoustic Phonon Emission on Heat Dissipation at Nanoscale," International Communications of Heat and Mass Transfer, Vol. 53, 2014, pp. 87-96. (DOI: 10.1016/j.icheatmasstransfer.2014.02.024)

Basil T. Wong, Mathieu Francoeur, and M. Pınar Mengüç, “A Monte Carlo Simulation for Phonon Transport within Silicon Structures at Nanoscales with Heat Generation,” International Journal of Heat and Mass Transfer, Vol. 54, Issues 9-10, 2011, pp. 1825-1838. (DOI: 10.1016/j.ijheatmasstransfer.2010.10.039)