Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Probing the low thermal conductivity of single-crystalline porous Si nanowires YUNSHAN ZHAO, Natl Univ of Singapore, LINA YANG COLLABORATION, LINGYU KONG COLLABORATION, BAOWEN LI COLLABORATION, JOHN T L THONG COLLABORATION, KEDAR HIPPALGAONKAR COLLABORATION — Pore-like structures provide a novel way to reduce the thermal conductivity of silicon nanowires, compared to both smooth-surface VLS nanowires and rough EE nanowires. Because of enhanced phonon scattering with interface and decrease in phonon transport path, the porous nanostructures show reduction in thermal conductance by few orders of magnitude. It proves to be extremely challenging to evaluate porosity accurately in an experimental manner and further understand its effect on thermal transport. In this study, we use the newly developed electron-beam based micro-electrothermal device technique to study the porosity dependent thermal conductivity of mesoporous silicon nanowires that have single-crystalline scaffolding. Based on the Casino simulation, the power absorbed by the nanowire, coming from the loss of travelling electron energy, has a linear relationship with it cross section. The relationship has been verified experimentally as well. Monte Carlo simulation is carried out to theoretically predict the thermal conductivity of silicon nanowires with a specific value of porosity. These single-crystalline porous silicon nanowires show extremely low thermal conductivity, even below the amorphous limit. These structures together with our experimental techniques provide a particularly intriguing platform to understand the phonon transport in nanoscale and aid the performance improvement in future nanowires-based devices.

Yunshan Zhao
Natl Univ of Singapore

Date submitted: 05 Nov 2015 Electronic form version 1.4