単層グラフェンの熱流束制御技術に関する研究

Active heat flow control in monolayer graphene

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Active heat flow control has a wide application in self-standing thermal computer, efficient energy harvesting, smart thermal management, etc. People have been designing different kinds of devices and systems to achieve this goal. In this talk, I would like to introduce recent progress in active heat flow control by using 2D materials. We have fabricated asymmetric nano-structures in suspended monolayer graphene ribbon by using nano-manufacturing techniques, such as FIB, EBID, etc. The asymmetric nanopores or nanoparticles alter the phonon transport in graphene. Hence, the thermal conductivity of graphene ribbon is changed by reversing the heat flow direction. The result demonstrates that the thermal rectification behavior is more significant in graphene than in other 1D material. The highest rectification factor is 28% in graphene, while the previous reported value in carbon nanotube is only 7%. The underlying physics of thermal rectification is explained by using large-scale MD simulation. Two different physical mechanisms are revealed in this study. For the graphene with asymmetric nanopore defects, the different temperature and space dependence of thermal conductivity is the reason for thermal rectification. For the graphene with asymmetric particle deposition or tapered width, the different long-wave phonon scattering at the particles or boundaries is known to be the reason. The experimental result agrees well with the theoretical calculation.

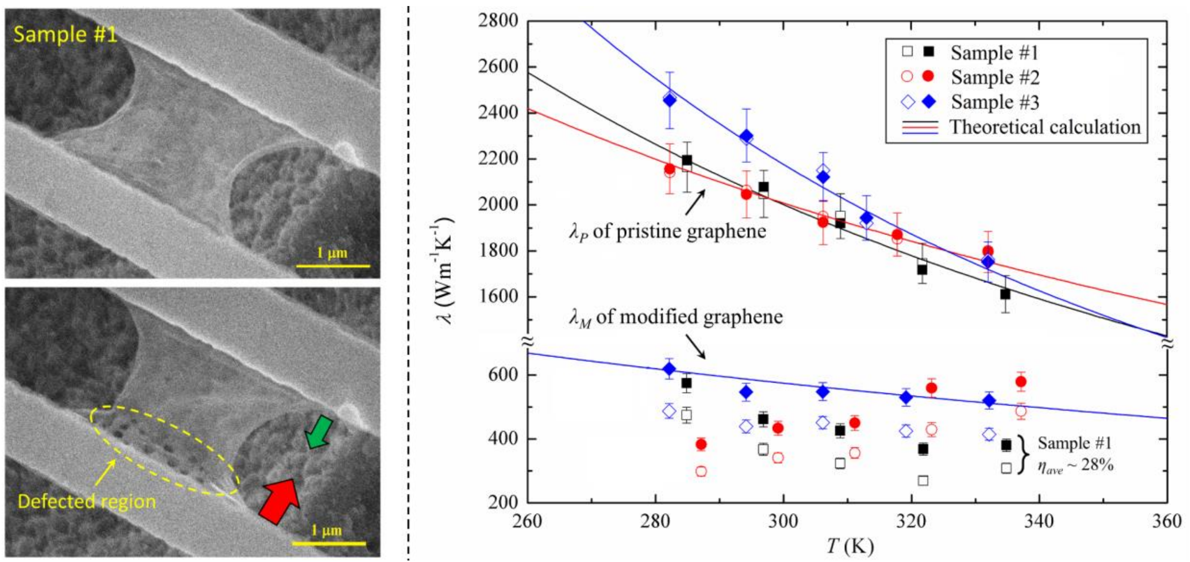

Fig. 1 Graphene rectifier with asymmetric nanopores and its thermal conductivity

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