Thermal conductivity of graphene

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Since its recent mechanical exfoliation, graphene attracted major attention of the scientific and engineering communities [1]. Graphene, which consists of a single atomic layer of hexagonally arranged sp^2-bound carbon atoms, revealed many unique properties including extremely high electron mobility. Owing to its properties, graphene emerged as a very promising material for electronic and spintronic applications. A number of devices have already been demonstrated.

In this talk I will overview our experimental results, which show that graphene is also a superior heat conductor. The latter together with graphene's flat geometry and demonstrated integration with Si make graphene a promising material for heat removal and thermal management. It also improves graphene's prospects of applications in electronic circuits. In order to measure the thermal conductivity of an object with a thickness of just one atom we undertook an unconventional approach and developed a technique based on the micro-Raman spectroscopy. Graphene flakes were suspended across trenches in Si wafers and attached to graphitic or metallic heat sinks. The flakes were heated by the focused laser light in the middle of the suspended portion. The amount of laser power dissipated in graphene and the corresponding local temperature rise were determined from the integrated intensity and position of graphene's Raman G mode. The G-peak position as a function of sample temperature was measured independently allowing us to convert the spectrometer into a "thermometer" [2]. Our measurements revealed that the single-layer graphene has an extremely high room-temperature thermal conductivity exceeding ~3080 W/mK [3-4]. The reasons for the unusually high thermal conductivity of graphene and its dependence on the number of atomic layers will be discussed in details. The results of theoretical studies of the thermal conductivity of graphene using Klemens' model [5] and some other approaches will also be presented.

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