Measuring Heat Flow in Electrospun Polymer Nanowires Using the Dual Cantilever Technique

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Bi-material microcantilevers, with their high sensitivity to thermal stimuli, are well known as thermal sensors. Though they have been used for more than two decades as heat flux and/or temperature change sensors, they have only recently been used to measure thermal transport. We have designed and fabricated low thermal conductance bi-material microcantilevers by minimizing their width and thickness. Using such cantilevers, we have demonstrated heat flux resolution of less than 1 picowatt. A pair of such cantilevers is proposed as a configuration for measuring thermal conductance of a nanostructure suspended between the two. In our cantilever technique, two lasers are focused, one on each cantilever. One laser is modulated to vary the temperature at the end of one cantilever, while the second laser senses variation in heat flow through the second cantilever due to thermal conduction along the nanowire. Segments of electrospun polystyrene nanowires are suspended between the two cantilevers and the heat flow through such nanowires is quantified by measuring the cantilever deflection. Thermal conductivity of the nanowire samples is found to be between 6.6 and 14.4 Wm^{-1}K^{-1} depending on sample, a significant increase above typical bulk conductivity values for polystyrene. The high strain rates characteristic of electrospinning are believed to lead to alignment of molecular polymer chains, and hence the increase in thermal conductivity, along the axis of the nanowire. We have designed and fabricated low thermal conductance bi-material microcantilevers by minimizing their width and thickness. Using such cantilevers, we have demonstrated heat flux resolution of less than 1 picowatt. A pair of such cantilevers is proposed as a configuration for measuring thermal conductance of a nanostructure suspended between the two. In our cantilever technique, two lasers are focused, one on each cantilever. One laser is modulated to vary the temperature at the end of one cantilever, while the second laser senses variation in heat flow through the second cantilever due to thermal conduction along the nanowire.