10th U.S.-Korea Nano Forum, Boston, MA
October 15-16, 2013

Sub-picowatt heat flow measurements & application to measurement of thermal properties of nanostructures

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Abstract

Bi-material microcantilevers are ideally suited thermal sensors for investigating nanoscale heat transfer. We have designed and fabricated low thermal conductance bi–material microcantilevers with a pad area near the free end to accommodate a focused laser spot, keeping them suitable for detection with an optical deflection technique. The conductance of one such cantilever is determined experimentally to be 330 ± 20 nWK^{-1}. Using this cantilever, we have measured less than 1 picowatt of heat flow through the cantilever. A pair of such cantilevers is proposed as a configuration for measuring thermal conductance of a nanostructure suspended between the two. We have determined the resolution of such a device by measuring the background conductance it would detect in the absence of any nanostructure. The background conductance, primarily due to optical coupling, is measured for cantilevers with varying pad size and found to be as low as 0.05 nWK^{-1}, with cantilevers with larger pad size yielding the smallest background conductance.