**abstract**

Near-field thermal radiation occurs when the distance between two surfaces at different temperatures is less than the characteristic wavelength of thermal radiation. While theoretical studies predict that the near-field radiative heat transfer could exceed Planck’s blackbody limit in the far-field by orders of magnitudes depending on the materials and gap distance, experimental measurement of super-Planckian near-field radiative heat flux is extremely challenging in particular at sub-100-nm vacuum gaps and few has been demonstrated. The objective of this thesis is to develop a novel thermal metrology based on AFM bi-material cantilever and experimentally measure near-field thermal radiation. The experiment setup is completed and validated by measuring the near-field radiative heat transfer between a silica microsphere and a silica substrate and comparing with theoretical calculations. The bi-material AFM cantilever made of SiNi and Au bends with temperature changes, whose deflection is monitored by the position-sensitive diode. After careful calibration, the bi-material cantilever works as a thermal sensor, from which the near-field radiative conductance and tip temperature can be deduced when the silica substrate approaches the silica sphere attached to the cantilever by a piezo stage with a resolution of 1 nm from a few micrometers away till physical contact. The developed novel near-field thermal metrology will be used to measure the near-field radiative heat transfer between the silica microsphere and planar SiC surface as well as nanostructured SiC metasurface. This research aims to enhance the fundamental understandings of radiative heat transfer in the near-field which could lead to advances in microelectronics, optical data storage and thermal systems for energy conversion and thermal management.