Nanoscale Thermal Probing in Particle-Induced Near-Field Focusing

Xiaoduan Tang and Xinwei Wang [C, S]
Iowa State University, Dept. of Mechanical Engr., Ames, IA, U.S.A.
xwang3@iastate.edu

A micro/submicron particle induced near-field effect can focus the incident laser beam to a small region of tens of nanometers (nm). This phenomenon has been widely used in surface nanostructuring, particle-assisted surface nanostructure imaging under normal optical microscope, and surface enhanced Raman spectroscopy. Despite various research efforts in the literature on the near-field focusing effect, no experiment has been reported on characterizing the temperature field induced by the extremely focused laser beam. In this work, we report on novel and pioneering experiment to measure the temperature of a region less than 100 nm size induced by near-field focusing. Raman spectroscopy is used for temperature measurement by observing the Raman frequency shift. Great measures have been taken to rule out the tiny Raman frequency drift in the experiment to ensure high-accuracy temperature measurement with an accuracy around 0.1 K. The effects of particle size and laser beam energy are fully investigated. Most importantly, for the first time we demonstrate that even though the laser beam is about mm size, we could achieve a resolution about 50 nm or smaller in terms of measuring the temperature distribution in space. This represents the first experimental measurement of the near-field focused laser beam distribution in space and its induced thermal field.