Near-field scanning thermal microscopy

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A macroscopic dielectric body with finite temperature emits heat radiation associated with propagating modes of the electromagnetic field. Besides, there are thermally excited evanescent modes tied to its surface. These evanescent modes give rise to a highly efficient form of heat transfer, due to photon tunneling, when two bodies with different temperatures are brought closely together, such that their thermal near-fields overlap.

This talk will report on joint experimental and theoretical work performed at Oldenburg University which aims at systematically exploiting the radiative near-field heat transfer between a sample and a small probe. The theoretical framework provided by Rytov's fluctuational electrodynamics will be reviewed briefly, and the realization of a Near-Field Scanning Thermal Microscope (NSThM) will be discussed. A somewhat simplified sensor model will then be employed for explaining the near-field heat transfer experimentally measured between a nanostructured surface and a miniaturized thermocouple. Taken together, these developments show that nanoscale thermal imaging of surfaces is feasible, and thus open up new possibilities for both basic and applied materials science.