Infrared phononic nanoantennas: Localized surface phonon polaritons in SiC disks.

AMEEN Mohamed[1], GARCIA-ETXARRI Aitzol[1], SCHNELL Martin[2], HILLENBRAND Rainer[2], AIZPURUA Javier[1].

1. Donostia International Physics Center, DIPC & Centro de Fisica de Materiales, CSIC-UPV/EHU, San Sebastian 20018, Spain.
2. Nanooptics Group, CIC Nanogune Consolider, San Sebastian 20018, Spain.

aizpurua@ehu.es

Electromagnetic interaction of light with the interfaces of polar materials shows a sharp and well defined electromagnetic response in the infrared (IR) region that consists mainly of excitation of optical phonons. Similar to surface plasmons in the visible region, surface phonons can couple efficiently to infrared light in micron-sized particles made of polar materials. This interaction forming localized surface phonon polaritons cause antenna effects, like enhanced absorption and scattering of electromagnetic radiation in some particular frequencies and enhancement & localization of electromagnetic field, allowing micron sized-structures of polar materials to act as micro/nano antennas in the infrared.

We apply the boundary element method to calculate the infrared electromagnetic response of single SiC disks acting as effective infrared antennas as a function of different parameters such as disk size (800 – 1200 nm) and thickness (50 – 100 nm). We also analyzed the effect of locating a near-field probing metallic tip near the SiC disk to scatter light, thereby obtaining new spectral peaks connected with localized modes between the tip and the SiC disk. We then further investigated their application in IR scanning probe microscopy. A near-field map of the phononic resonances improves the understanding of the nature of the IR extinction peaks. Finally, the effect of placing the nanoantenna on different substrates is studied.

References

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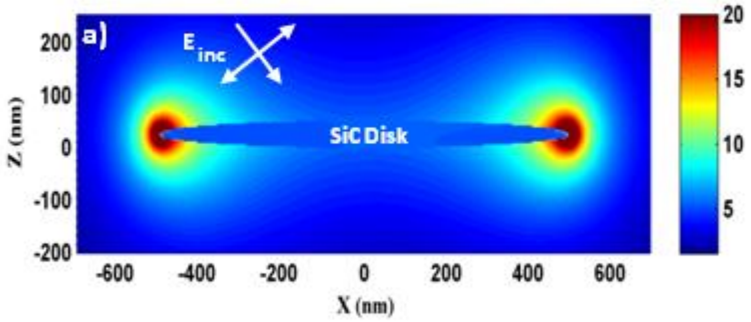
Figures



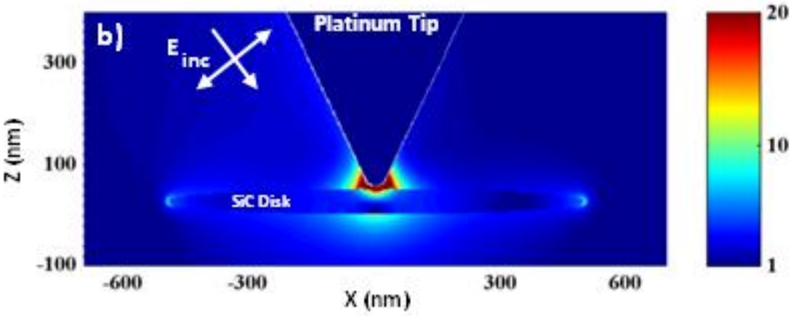


Figure caption

a) *Near-field amplitude distribution around a SiC disk nanoantenna with size 1000 nm and thickness 50 nm at an incident wavelength of 12.1 micrometer. Incident field E_{inc} is displayed in the figure.*

b) *Same situation as in Figure a, but in the presence of a metallic probing tip. Localized electromagnetic mode emerges from the interaction of the metallic probing tip with the nanoantenna. The incident wavelength is 11.6 micrometer.*