249

Accession number:20114514498935

Title:Scattering of the near field of an electric dipole by a single-wall carbon nanotube

Authors:Nemilentsau, Andrei M. (1); Slepyan, Gregory Y. (1); Maksimenko, Sergey A. (1); Lakhtakia, Akhlesh (2); Rotkin, Slava V. (3)

Author affiliation:(1) Belarus State University, Institute for Nuclear Problems, 11 Bobruiskaya Street, Minsk 220030, Belarus; (2) Pennsylvania State University, Department of Engineering Science and Mechanics, NanoMM-Nanoengineered Metamaterials Group, University Park, PA 16802, United States; (3) Lehigh University, Department of Physics, Center for Advanced Materials and Nanotechnology, 16 Memorial Dr. E., Bethlehem, PA 18015, United States

Corresponding author:Nemilentsau, A.M.(andrei.nemilentsau@gmail.com)

Source title:Journal of Nanophotonics

Abbreviated source title:J. Nanophoton.

Volume:4

Issue:1

Issue date:2010

Publication year:2010

Article number:041685

Language:English

ISSN:19342608

CODEN:JNOACQ

Document type:Journal article (JA)

Publisher:SPIE, P.O. Box 10, Bellingham, WA 98227-0010, United States

Abstract:The use of carbon nanotubes as optical probes for scanning near-field optical microscopy requires an understanding of their near-field response. As a first step in this direction, we investigated the lateral resolution of a carbon nanotube tip with respect to an ideal electric dipole representing an elementary detected object. A Fredholm integral equation of the first kind was formulated for the surface electric current density induced on a single-wall carbon nanotube (SWNT) by the electromagnetic field due to an arbitrarily oriented electric dipole located outside the SWNT. The response of the SWNT to the near field of a source electric dipole can be classified into two types, because surface-wave propagation occurs with (i) low damping at frequencies less than ~ 200-250 THz and (ii) high damping at higher frequencies. The interaction between the source electric dipole and the SWNT depends critically on their relative location and relative orientation, and shows evidence of the geometrical resonances of the SWNT in the low-frequency regime. These resonances disappear when the relaxation time of the SWNT is sufficiently low. The far-field radiation intensity is much higher when the source electric dipole is placed near an edge of SWNT than at the centroid of the SWNT. The use of an SWNT tip in scattering-type scanning near-field optical microscopy can deliver a resolution less than ~ 20 nm. Moreover, our study shows that the relative orientation and distance between the SWNT and the nanoscale dipole source can be detected.

Number of references:45