OFFICIAL ABSTRACT and CERTIFICATION

Simulating Nanoscale Imaging of Plasmonic Excitations and Cancer Cells under Near-field Nanoscopy

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Scattering-type scanning near-field optical microscopy (s-SNOM) is an advanced optical method to achieve fine resolution at the nanoscale. s-SNOM provides novel opportunities to study a variety of materials, such as strongly correlated quantum materials (SCQMs), and processes such as plasmonic excitations in gold nanoparticles at infrared and terahertz frequencies. Studying the optical properties of advanced materials, including the plasmonic resonances of gold particles, as well as the optical responses of normal and cancerous human cells, provides fundamental insights for the the application of nano-imaging techniques to the medical field, such as in cancer diagnosis. In this work, the discrete dipole approximation is implemented to simulate s-SNOM imaging and spectroscopy. Results from s-SNOM spectroscopy simulations of silicon carbide (SiC) and silicon dioxide (SiO2) are presented, which have good agreement with previous theoretical, numerical, and experimental results. 2-dimensional imaging of gold nanoparticles and hexagonal boron nitride (hBN) are shown to accurately display plasmonic and polaritonic patterns. In addition, simultaneous imaging of normal human and breast cancer cells are shown to accurately display expected optical contrasts. The dipole approximation is thus shown to have novel applications for a variety of optical applications, including the imaging of plasmonic and polaritonic excitations as well as cancer cells, with implications for future imaging techniques using plasmonic field enhancement as well as optical cancer diagnosis.

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