Multi-probe Integration of Near-field and Electron Optics: Transport Imaging for the Nanoworld

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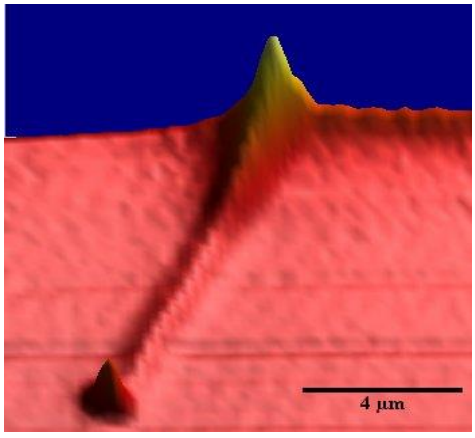
Abstract

Integration of near-field scanning optical microscopy (NSOM) with the imaging and localized excitation capabilities provided by electrons in a scanning electron microscope (SEM) offers new opportunities for the direct observation of highly resolved energy transport. We utilize the flexibility inherent in the independent, high resolution placement of the electron beam (for the generation of free carriers, photons and/or plasmons), in combination with scanning of an NSOM tip, to enable unique types of dual-probe experiments. This "transport imaging" is related to, but different from standard cathodoluminescence, because it maintains the spatial information in the emitted light. One can "see" the transport of carriers and determine minority carrier or exciton diffusion lengths from a single picture and map spatial variations in drift and diffusion behavior properties. Transport can be imaged in materials of all dimensions - bulk, thin films and nanostructures - with the use of appropriate models. These applications will be illustrated with examples from ordered alloys, multi-junction solar cells and GaN and ZnO nanostructures. In addition, a short overview of the work of the National Renewable Energy Laboratory (NREL) in the area of fundamental and applied materials science discovery and problem-solving for current and next-generation renewable energy and energy efficient technologies will be provided.



Spatial carrier diffusion and optical waveguiding in a ZnO nanowire in response to point source e beam excitation.