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Mapping surface plasmon polaritons by near-infrared dual-probe scanning near-field optical microscope

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Scanning near-field optical microscopy (SNOM) is a powerful technique to visualize optical phenomena within the near-field region of optical nanostructure. In standard aperture SNOM measurements, there is a small aperture which serves as a point-like emitter or detector of light. In dual-probe SNOM, there are two aperture tips which simultaneously illuminate and collect the light on a surface of nanostructures. In the dual-probe configuration, both illumination and collection resolution depends on the aperture size and can overcome the diffraction limit. Furthermore, the measurement signal is not influenced by background radiation stemming from an illumination laser spot. Although the dual-probe SNOM measurements have been reported for the measurement of surface plasmon polaritons (SPPs) propagation as well as local carrier dynamics in quantum wells, due to complications of dual-probe SNOM measurements, this technique is not yet a common near-field characterization method. Recently, we have introduced a fully automated and robust dual-probe SNOM technique which has facilitated the robust implementation of the measurement. In this technique, a reliable collision avoidance scheme only based on shear force interaction between two tips is employed. The fully automated dual-probe technique not only simplifies the application of dual-probe SNOM, but a low noise electronic also leads to considerably improved data acquisition. In this work, we demonstrate the capability and stability of the method by measuring SPPs propagation for near-infrared excitation. The illumination probe excited SPPs on a gold film at 1550 nm wavelength. The SPP propagation is mapped on an area around the illumination probe by raster scanning of the collection probe. A computer-controlled collision avoidance scheme prevents the collision of two probes. Therefore, the optical signal is mapped without user interference. The fully automated dual-probe SNOM could open up a new possibility to quantitatively investigate and image the optical field interaction with plasmonic and dielectric devices as well as surface wave propagation.

Biography

Najmeh Abbasirad is currently pursuing her PhD in Nano-optics group at the Institute of Applied Physics, Friedrich Schiller University Jena under supervision of Prof. Thomas Pertsch. At present her research focuses on near-field optical microscopy and developing dual-probe SNOM for characterization of optical nanostructures.

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