Light Emitting Semiconductor Nanostructures Studied by SNOM

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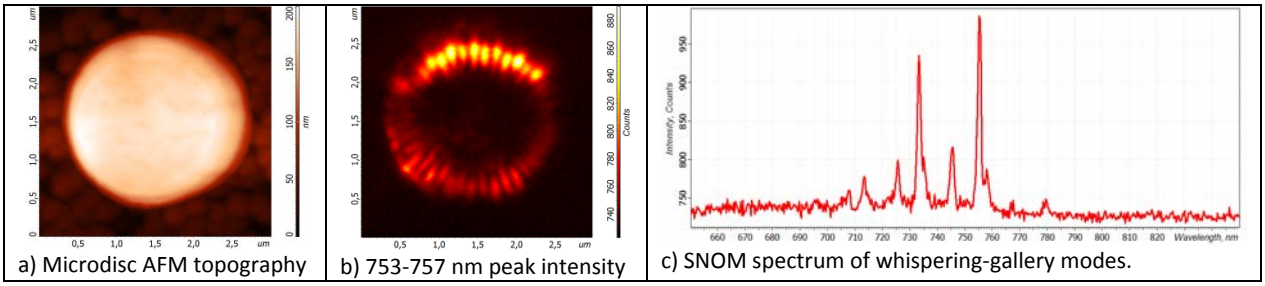
Abstract

We review our recent SNOM studies on semiconductor laser, quantum dots and quantum microdisks in near-IR spectral region.

The near- and the far-field distributions of propagating light modes from a high-power laser diode were studied by aperture SNOM in XYZ-mapping regime. Diode laser has a line shape 100 μm-aperture and emits in the range 1073-1075 nm. Simple modeling of 3D light emission distribution was also performed and compared with experimental results. The simulated distributions were consistent with the experiment and permitted clarification of the configuration of the transverse modes of the laser. On the emitting facet, in the near-field, an asymmetric distribution of the radiation was revealed, which manifests the mixing of the odd and even (1st and 2nd) modes. 3D light emission distribution measured by SNOM is compared to that measured by a confocal microscope using objectives with different numerical aperture. Resolution and light collection limits of classical confocal microscopy are explicitly demonstrated.

Photoluminescence (PL) of self assembled InP/GaInP quantum dots (QDs) of different sizes from 10 to 200 nm were studied. Illumination-collection regime was used (excitation and emission collection through the same SNOM aperture). Hyperspectral SNOM photoluminescence maps resolving individual QDs could be easily obtained. PL spectra of individual QDs (with emission at 700-780 nm) were measured; spectral differences between QDs of different sizes were studied. Initial fluorescence lifetime imaging SNOM measurements were also performed.

Configuration with far field side excitation under the SNOM cantilever probe and collection through SNOM aperture was applied to investigate whispering-gallery modes distribution in a semiconductor microdisk resonator of 2 μm diameter containing InP/GaInP QDs. Fine structure of optical whispering gallery (circular) and Fabry Perot (radial) modes were identified both spectrally and spatially. On the image below shown simultaneously obtained topography (a), distribution of selected peak intensity (753-757 nm range) (b) corresponds to a whispering-mode distribution in the resonator. Typical near-field microdisk spectrum is shown on the image (c).



a) Microdisc AFM topography b) 753-757 nm peak intensity c) SNOM spectrum of whispering-gallery modes.

References

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