

Towards Optical Whispering Galleries

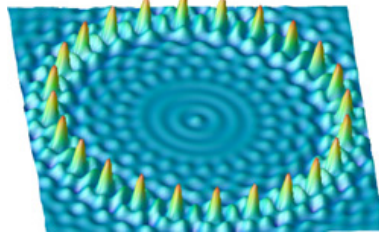
Yelizaveta Babayan & Teri W. Odom



NORTHWESTERN UNIVERSITY

Objective: To manipulate and confine light within patterned structures for the investigation of an optical analog to the quantum corral and quantum mirage. These evanescent standing waves have potential applications in high sensitivity optical sensors and photonic computing.

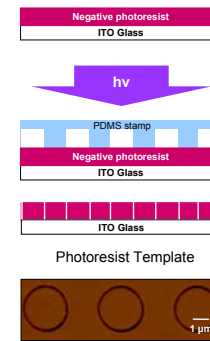
Methods: Ring and elliptical structures are generated using soft and e-beam lithography, respectively. Optically active materials such as semiconducting quantum dots and gold are used to fill the templates to generate the mesoscale corrals. The optical properties of the corrals are investigated using near-field scanning tunneling microscopy (NSOM).



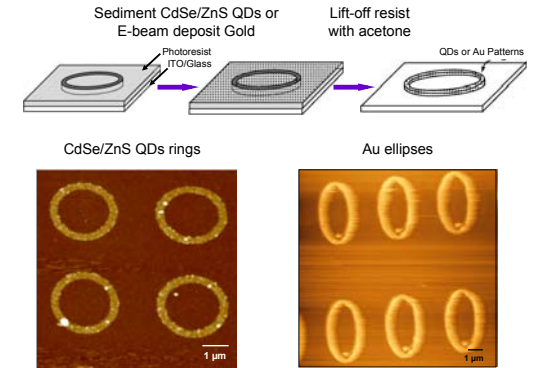
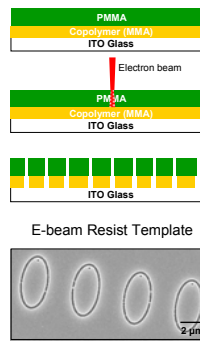
Phys. Rev. Lett. 2001, 86, 4950.

Patterning and Assembly

Phase-Shifting Photolithography



Electron Beam Lithography

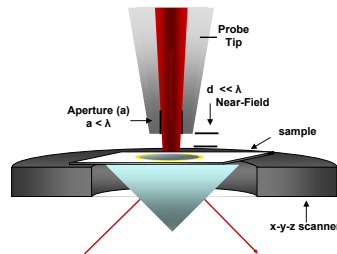
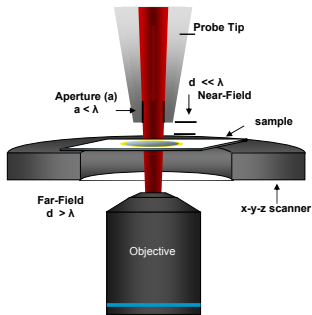


Near-Field Imaging of Optical Corrals

- Combines high resolution of electron microscopy with the sensitivity, specificity, and flexibility afforded by optical techniques
- Provides spatial resolution beyond the classical diffraction limit

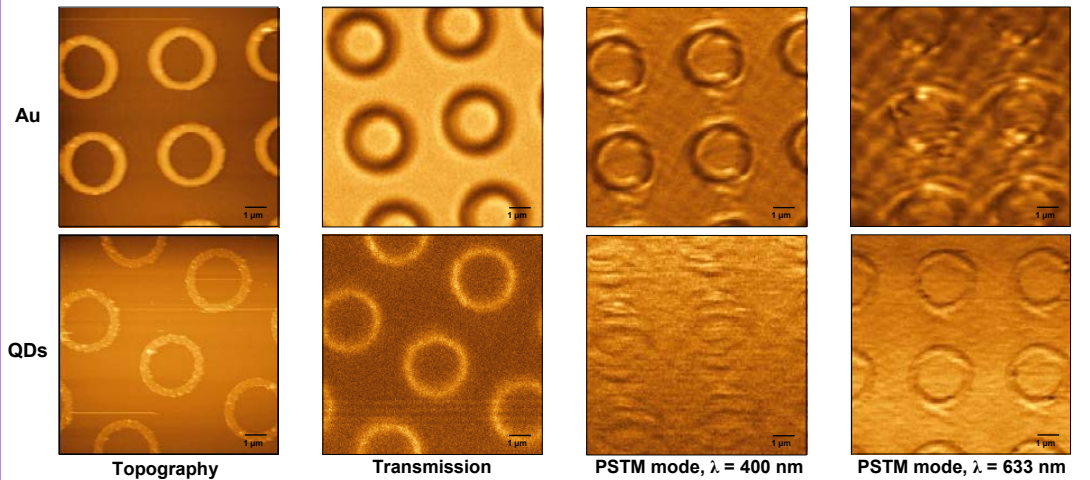
Transmission Mode - the sample is illuminated through the probe, and the light passing through the sample is collected and detected.

Photon Scanning Tunneling Microscopy (PSTM) mode - the sample is illuminated with an evanescent field generated by total internal reflection inside a glass prism to which the sample is optically coupled, and the probe is used for collection of the signal.

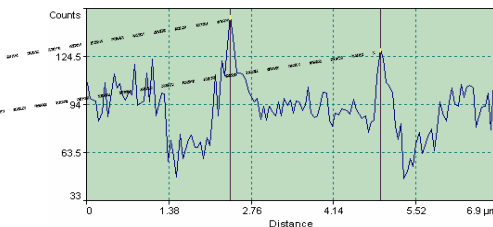
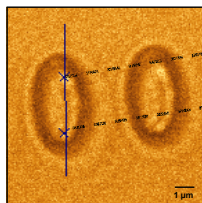
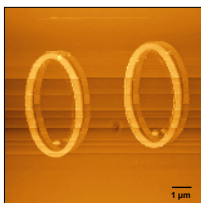


Light Confinement in Corrals

We are studying the effects of structure, material, wavelength, and polarization on the confinement of the near-field light in the corrals.



Optical Mirage?



Future Experiments

- Characterize evanescent waves confined within solid QD & Au rings.
- Construct structures with different sizes analogous to the quantum mirage by e-beam lithography for studies of an optical mirage effect.
- Image rings & ellipses with different wavelengths of light.
- Image rings & ellipses different polarization of light in PSTM.
- Characterize the difference between metallic and semiconducting structures.