# Optical emission and control in the single-wall carbon nanotube quantum dots

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One of the unique features of carbon nanotubes is the possible chemical modification of surfaces and edges. We use this feature to fabricate single-wall carbon nanube (SWNT)-based nanostructures in combination with molecules. A single quantum dot was fabricated with the SWNT with both ends terminated by molecules. The SWNT and the molecule were connected by the ester-linkages. Special care was taken such that the chemical modification occurred only at both ends of the nanotubes, not at the surface of the nanotube. It was possible because the chemical modification tends to occur at positions where defects exist, and the edges are more likely to have defects.

In this work, optical properties were studied for an individual quantum dot at a liquid He temperature. The quantum dots were fabricated with chemical processes in solution and were dispersed on the $SiO_2$/Si substrate. The typical “length” of the quantum dots was 50-500nm. They are characterized by the scanning tunneling microscope (STM) with optical characterization capabilities. The scanning tunneling spectroscopy (STS) measurements were carried out for the quantum dot dispersed on a metal surface. STS measurements revealed free-electron like density of states confined in the entire SWNT with a seemingly parabolic potential. A ground state and excited states were observed as the tip bias voltage was incresed. Besides, the tip-induced light emission was observed from the quantum dot. Photoluminescence excitation spectroscopy was carried out for the individual quantum dots, where discrete lines along the excitation axis were observed, which may be coming from the exciton confinement in the quantum dot. The Rabi-splitting and the anti-crossing in the dispersion relation were observed in the strong excitation regime, and control of the exciton emission was also performed by irradiating time-delayed two pulses.