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Polarized-Photoluminescence Excitation Spectroscopy of Aligned Single-Walled Carbon Nanotubes

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Optical transitions of (6,5) and (7,5) single-walled carbon nanotubes (SWNTs) were investigated by polarized photoluminescence excitation (PLE) spectroscopy of 2-dimentionally aligned individual nanotubes in gelatin-based thin film. Optical transitions for perpendicularly polarized light to the nanotube axis were directly observed in addition to well assigned transitions for parallel polarization. While all PL peaks in PLE spectra were classified into either 'pure electronic' or 'electron-phonon coupling' peaks by measuring PLE spectra of isotopically modified SWNTs consisting of carbon-13 isotope, all the observed 'pure electronic' peaks were consistently assigned to electronic transitions corresponding to incident light polarized parallel or perpendicular to the nanotube axis. These results are consistent with the considerably asymmetric structure of electronic energy dispersion relation predicted by GW-level DFT results. This large asymmetry resulted in very close energeti c values between transitions for parallel and perpendicularly polarized light, suggesting the apparently wide resonance window if depolarization effect is imperfect, for example, SWNTs are bundled or surrounded by some dielectric materials such as gelatin or surfactant.