Supporting Information

High Quantum Efficiency of Band-Edge Emission from ZnO Nanowires
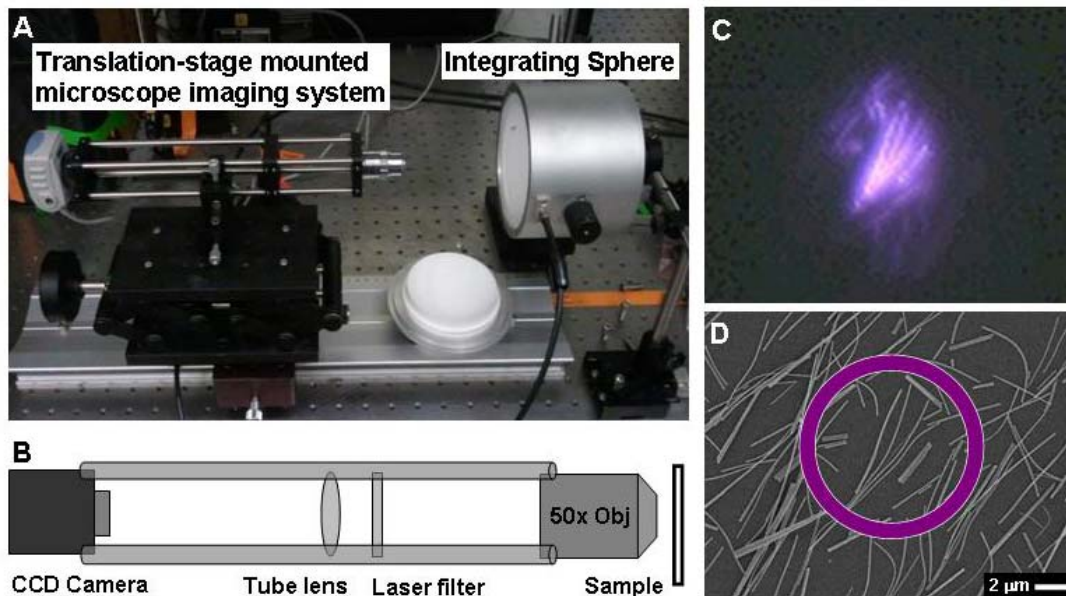
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Figure S1. Microscope imaging system coupled to integrating sphere. A) Microscope imaging system mounted on a translation stage for positioning inside the integrating sphere. B) Schematic diagram of imaging system. C) PL image of ZnO nanowires on quartz substrate collected from inside the integrating sphere. D) SEM image of same region of ZnO nanowire sample shown in C).
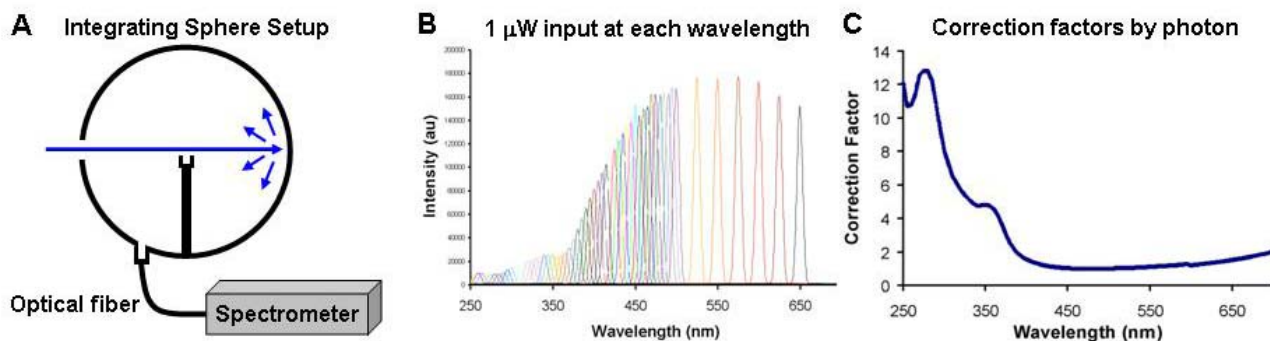

Figure S2. Spectral calibration of integrating sphere setup. A) Schematic diagram of integrating sphere coupled to CCD-spectrometer via optical fiber. B) For spectral calibration of the integrating sphere setup, 1 μW of power was input into the sphere and measured at wavelengths every 5 nm from 250 – 800 nm. The input light was measured by a calibrated photodiode. C) Integrating sphere correction factors plotted per wavelength. Correction factors were normalized to λ = 470nm.
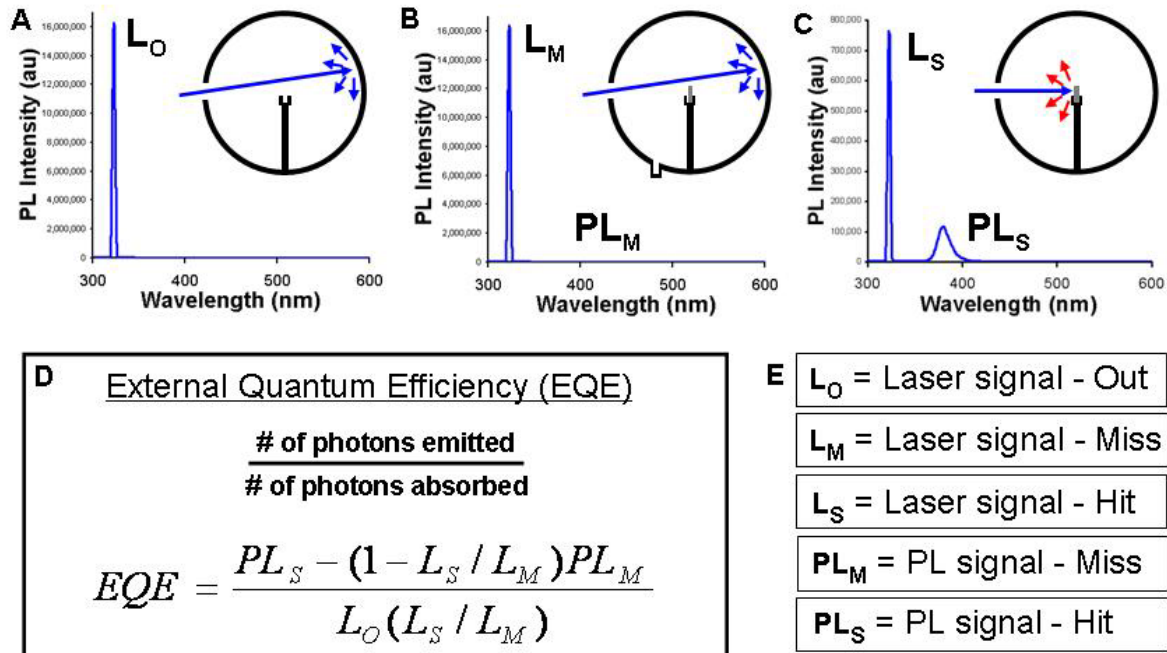
Figure S3. Calculation of External Quantum Efficiency (EQE). EQE measurement spectra from A) out, B) miss, and C) hit. Inset diagrams show excitation laser entering integrating sphere A) without the sample, B) missing the sample, and C) hitting the sample. D) EQE equation based on the laser and photoluminescence signals from each measurement spectra. E) Legend defining laser and photoluminescence signals presented in A) – D).
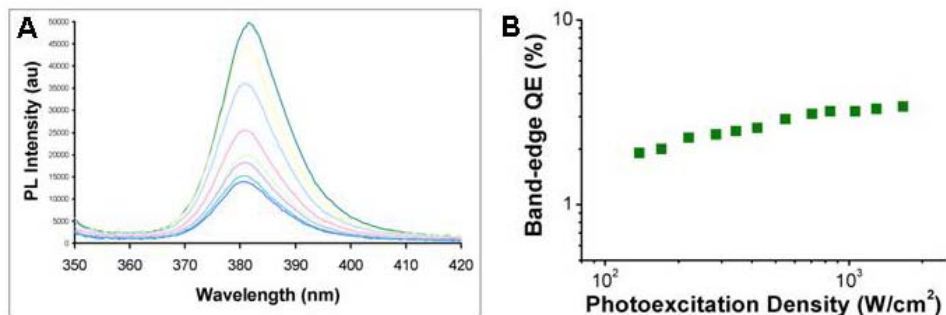
Figure S4. EQE of ZnO powder (Aldrich, 99.999%) on blank quartz. A) PL spectra of ZnO powder measured with integrating sphere at increasing photoexcitation density. B) Log-log plot of ZnO powder EQE vs photoexcitation density.
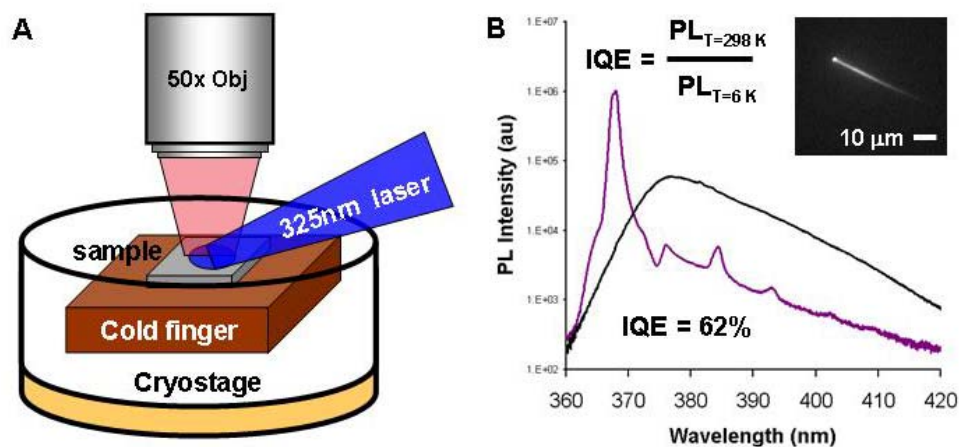
Figure S5. Internal quantum efficiency (IQE) measurement of single ZnO nanowires. A) Diagram of IQE experimental setup. B) PL spectra measured from single ZnO nanowire at T=6 K (purple curve) and T=298 K (black curve). IQE was calculated from ratio of integrated PL signal. Inset: PL image of single ZnO nanowire in IQE measurement.
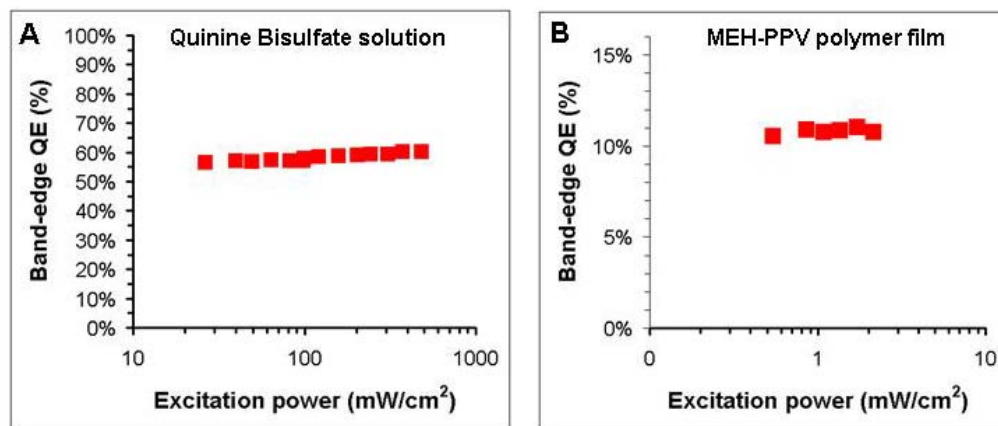
Figure S6. Measured EQE of A) Quinine Bisulfate solution and B) MEH-PPV polymer film at increasing photoexcitation densities. Accepted literature values are 60% $\pm$2% and 12.5% $\pm$2.5% for Quinine Bisulfate and MEH-PPV, respectively.