Supporting Information

Large Optical Stark Shifts in Single Quantum Dot coupled to Core-Shell GaAs/AlGaAs Nanowire

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Figure S1. Raman spectrum of GaAs/Al\textsubscript{x}Ga\textsubscript{1-x}As core-shell nanowire (NW). The NW was shaved from the growth substrate and then transferred to a Si substrate for test. The Al composition of the Al\textsubscript{x}Ga\textsubscript{1-x}As shell can be determined using the fitted curves that relate the LO-phonon frequency with the aluminum content x~0.7 in the Al\textsubscript{x}Ga\textsubscript{1-x}As system, according to the reference equations\textsuperscript{[1,2]}. 
Figure S2. Aberration-corrected high-angle annular dark-field STEM images of the entire cross section of a typical GaAs nanowire coated with AlGaAs shells, along with energy dispersive X-ray spectroscopy (EDX) spot scans. In the STEM image, the lighter regions are corresponding to GaAs and the darker region to $\text{Al}_{0.7}\text{Ga}_{0.3}\text{As}$. We observe the formation of little darker stripes at some of the nanowire corners, indicating Al enrichment (~80%). This little accumulation is consistent with the difference in chemical potential on (110) facets [2-4].

Figure S3. (a) Spectra of the SHG signals under different excitation wavelengths from 800 nm to 1040 nm, the excitation power is kept at 2.5mW. (b) The SHG intensities under different excitation powers, the excitation wavelength is kept at 1040 nm. (c) The SHG intergrated intensities and linewidths as a function of the pumping power.
laser power. The quadratic dependency of the SHG indicates the signal is generated from a second-order nonlinear process.

**Figure S4.** (a) Power dependence of the QD emission under down-conversion using 512 nm excitation. (b-d) Power dependence of the QD emission under up-conversion excitation using different wavelengths of 840 nm, 900 nm, 1040 nm.