

End-to-End Alignment of Nanorods in Thin Films

Supporting Information

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S1. Nanorod preparation and characterization

CdS nanoparticles were synthesized according to well-established CdO-based synthetic procedures [1]. Briefly, 2.75 g tri-n-octylphosphine oxide (TOPO), 1.08 g n-octadecylphosphonic acid (ODPA), and 207 g CdO were degassed at 140°C under vacuum for about 15 minutes then heated to 320°C under argon. During the heating, most of the CdO is converted into a cadmium phosphonate complex, but releases water. After about 15 minutes at 320°C, the solution is cooled back to about 140°C and degassed under vacuum again for more than an hour. After degassing is complete, the solution is reheated to 320°C, and 2 g tri-n-octylphosphine (TOP) was injected dropwise and the solution allowed to return to 320°C. 1.3 g of a sulfur-TOP stock solution (1:1 molar ratio of sulfur to TOP) was then rapidly injected. The temperature was allowed to stabilize at 315°C, and the reaction was allowed to proceed for 50 minutes. Growth was stopped by removal from heat. The nanorods were cleaned by repeated cycles of dissolution in octylamine/toluene, nonanoic acid/toluene, or toluene; precipitation with isopropanol; and centrifugation at 4000 RPM. Once purified, the toluene was removed using a rotovap, and the rods redissolved in chloroform for immediate use or hexane for storage. Nanorods used in this study have a diameter of $4.8 \text{ nm} \pm 1.8 \text{ nm}$ and a length of $60 \text{ nm} \pm 6 \text{ nm}$. With a dipole moment of 2.78 Debye/nm^3 [2], these rods have an average dipole moment of 1.2×10^4 Debye. A representative image can be seen in Figure S1a.

CdSe/CdS seeded nanorods were prepared according to the synthesis developed by Manna et al. [3]. Upon cleaning, nanorods were redissolved in chloroform for immediate use or hexane for storage. Nanorods used in this study have a diameter of $6.0 \text{ nm} \pm 1.5 \text{ nm}$ and a length of $40 \text{ nm} \pm 4 \text{ nm}$ or a diameter of $4.5 \text{ nm} \pm 1.5 \text{ nm}$ and a length of $20 \text{ nm} \pm 3 \text{ nm}$. Representative images can be seen in Figures S2a and S3a, respectively.

Nanorods were characterized by imaging in a TEM (an FEI Tecnai 12 TEM operating at a 120kV accelerating voltage) and subsequent measurement using an ImageJ [4] plugin based on the built-in “Particle Analysis” routine. Once at least 300 nanorods had been measured, the measurements were imported into Igor Pro, and a histogram calculated using the built-in histogram calculation functionality. A log normal function was then fit to the histogram to find the average length or width as well as the standard deviation. Histograms for the representative images can be found in Figures S1b, S2b, and S3b.

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[4] Rasband, W.S., ImageJ, U. S. National Institutes of Health, Bethesda, Maryland, USA, <http://imagej.nih.gov/ij/>, 1997-2012.

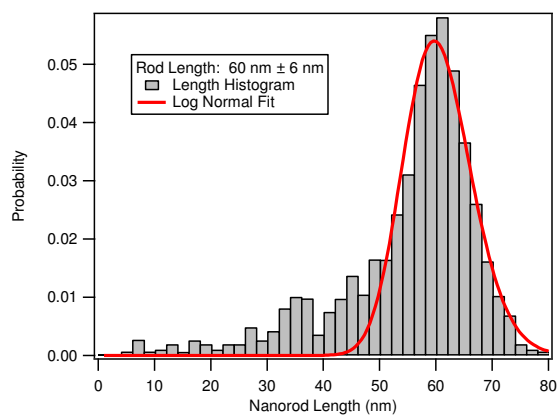


Figure S1. 60 nm CdS nanorod size distribution. **a)** A representative TEM image of the nanorods. **b)** Histogram of nanorod lengths for approximately 550 nanorods, and the log normal fit used to determine the length distribution.

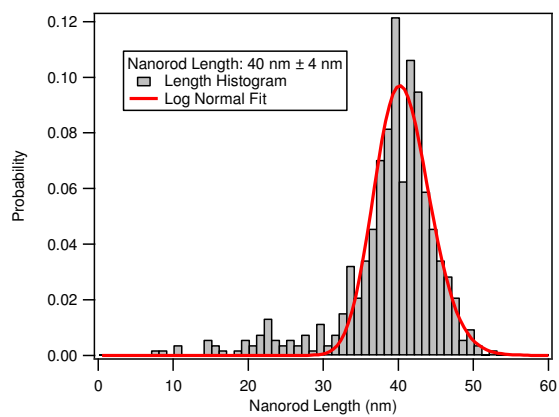
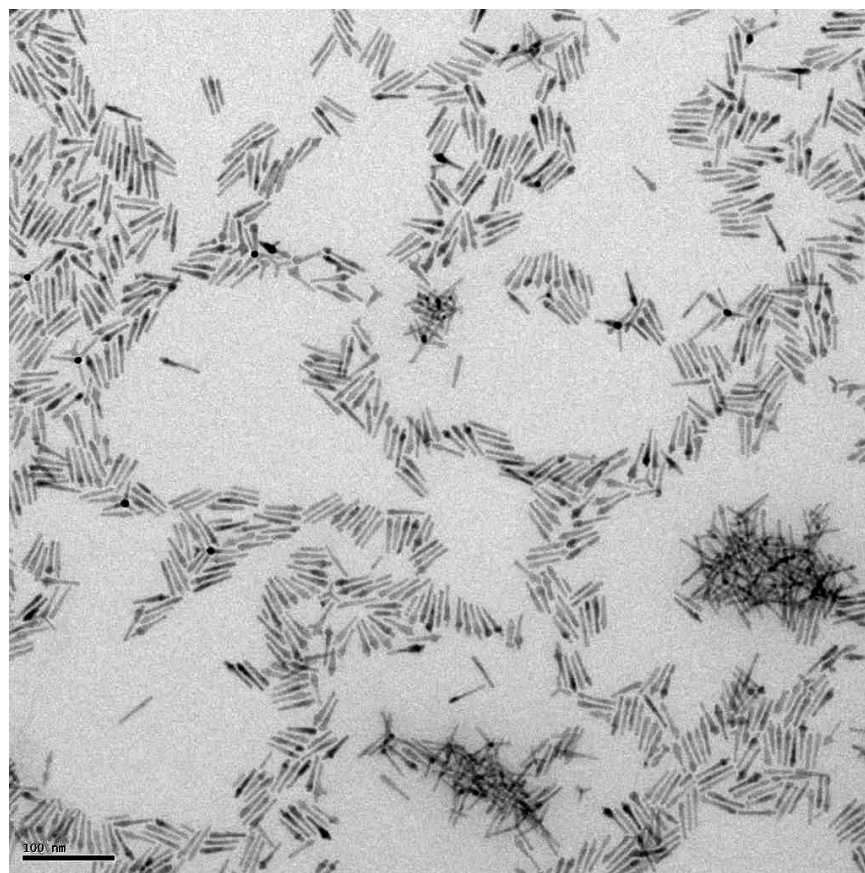


Figure S2. 40 nm CdSe/CdS nanorod size distribution. **a)** A representative TEM image of the nanorods. **b)** Histogram of nanorod lengths for approximately 525 nanorods, and the log normal fit used to determine the length distribution.

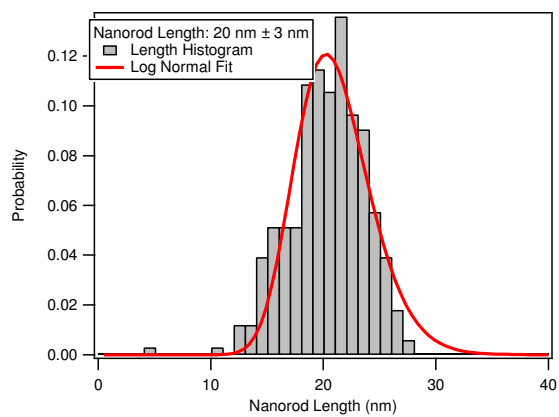
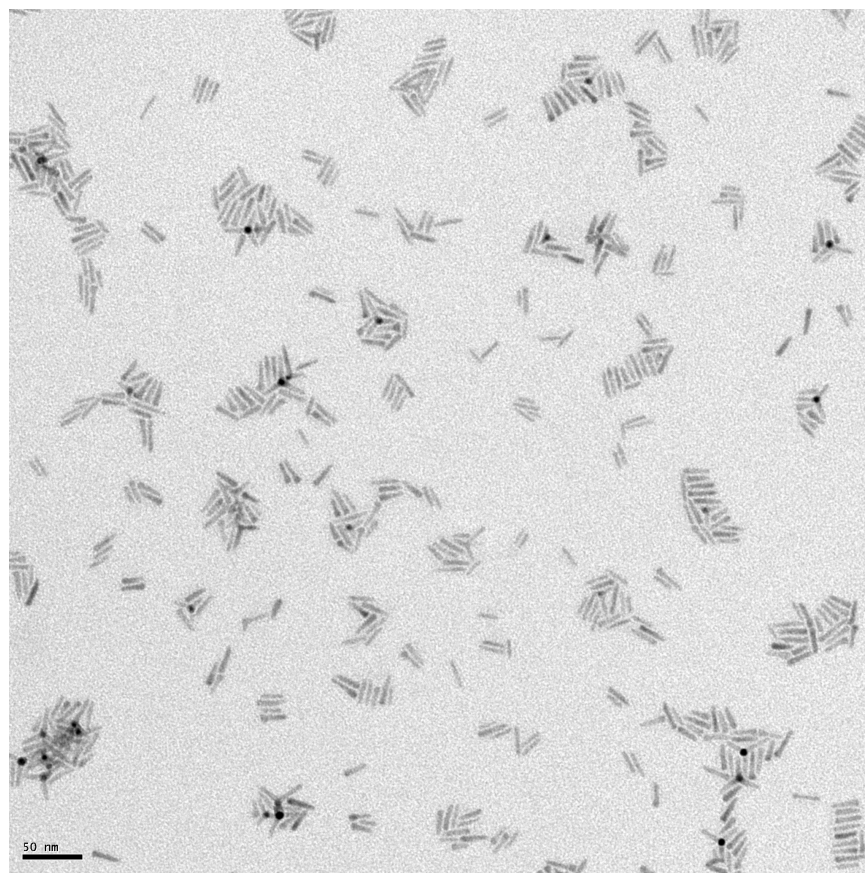


Figure S3. 20 nm CdSe/CdS nanorod size distribution. **a)** A representative TEM image of the nanorods. **b)** Histogram of nanorod lengths for approximately 330 nanorods, and the log normal fit used to determine the length distribution.