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Synthesis and electric characterization of protein-shelled CdSe quantum dots

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Electronic Supplementary Information

Experimental Section

Sample preparation and characterization

All chemicals used in this study were purchased from Sigma-Aldrich and used without further purification (Sigma, MO, USA). Ion-free water (conductivity ≤ 0.1 μS cm^{-1}) was prepared using a Milli-Q system (Millipore, Billerica, MA). The protein shell of ClpP from *Helicobacter pylori* was prepared as reported previously[1]. The concentration of ClpP was determined by Bradford assay using BSA as the standard. The CdSe nanoparticles were synthesized according to the previously reported procedure[2]. The 0.5 mL synthesis mixture with final concentrations of 1.50 μM ClpP, 1 mM cadmium acetate, 40 mM ammonium acetate, 7.5 mM ammonia water, and 10 mM selenenourea was prepared and left overnight at room temperature under stirring. Then, the solution was centrifuged at 13,200 rpm for 30 minutes at 4℃ to eliminate precipitants which can be formed by aggregation of CdSe particles grown outside the ClpP shells. The supernatant containing soluble ClpP-CdSe was desalted for further experiments.

Transmission electron microscopy (TEM) images were taken using a JEOL JEM-2100 microscope (JEOL, Tokyo, Japan) operated at 200 kV. TEM samples were prepared as described previously[3] by applying the ClpP-CdSe solution onto a copper grid covered with a thin carbon film (JEOL, Tokyo, Japan) and dehydrating the grid overnight at room temperature. ClpP-CdSe samples were stained on the copper grip with 2% uranyl acetate for 30 seconds. Energy dispersive X-ray spectroscopy (EDS)

data were obtained from the samples prepared for TEM. The size of CdSe was estimated by averaging 100 individual particles using Gatan Digital Micrograph software (Gatan, Pleasanton, CA). Inductively coupled plasma mass spectroscopy (ICP-MS) was carried out using an ELAN 6100 system (PerkinElmer, Waltham, MA) to determine the concentration of Cd and Se elements in the CdSe quantum dots inside the ClpP shells.

FET device fabrication

In the micro-gap FET device, seven source-and-drain electrodes with 5 μm gaps were loaded on a 500 μm Si that served as a back gate. Electrodes and Si layer were insulated by a 300 nm SiO_2 layer. The electrode is composed of a 5-nm titanium core covered by 25 nm gold. The *I-V* characteristics of ClpP and ClpP-CdSe on FET devices were investigated using a semiconductor parameter analyzer, 4200 SCS (Keithley Instruments, Inc., Cleveland, OH) (Fig. S1). The *I-V* curve was measured by sweeping the drain-to-source voltage from -5 to +5 V at 0 V gate voltages.

References

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