Supplementary Document

CdSe quantum dot synthesis

Synthesis procedure of colloidal CdSe quantum dots is given as follows. Cadmium oxide, CdO (Acros Org.); oleic acid, OA (JT Baker); 1-octadecene, ODE (Acros Org.); selenium powder (Acros Org.); 1-hexadecylamine, HDA (Acros Org.); and trioctylphosphine, TOP (Sigma Aldrich) have been used as pure as supplied from the companies without further purification. The cadmium stock solution has been prepared by mixing CdO, OA and ODE. The mixture is evacuated by raising the temperature to 100˚C and is then heated to 300˚C until a transparent solution is achieved. The injection solution is prepared by adding Se solution (in TOP, prepared in glove box at 200˚C) to TOP and ODE. The synthesis is carried under fumehood, with Schlenk line connected to vacuum and pure Ar line. During the synthesis Cd stock solution is mixed with TOPO, HDA and ODE in a 3-neck glass flask. The mixture is evacuated under Schlenk line with raising up the temperature to 100˚C under stirring. The mixture is then heated to 300˚C under Ar flow and the temperature for injecting TOP-Se-ODE mixture is set to be 280˚C. The nanocrystals are grown at 250˚C. The reaction mixture is cooled down to room temperature and nanocrystals are used after cleaning/purification.

Fabrication of Si nanopillar device

Si nanopillar arrays are formed by the electrochemical etching method combined with nanosphere lithography. The starting Si wafer (100) here is p-type (boron-doped) with a resistivity of 0.1-1 Ω•cm. The nanopillar diameter is defined by the nanosphere lithography. After the nanopillar formation, a novel diffusion process has been developed to convert the nanopillar shell to n-type, forming the radial *p-n* junction structure. After the junction formation, the contact is formed by depositing Ti/Au (~ 10 nm/100 nm) at the backside, and Ti/Ag (~ 30 nm/1000 nm) at the front side to form a continuous film on the nanopillar arrays.

Reflectivity measurements of nanopillar solar cell

The reflection measurements have been carried out for the nanopillar solar cells before and after the nanocrystal hybridization. In this set of experimental reflection data, we observe that the reflection of Si nanopillar solar cells drops off with the integration of quantum dots by 9-14%, which shows the function of quantum dot coating also as a graded index layer. This increases coupling of light into the nanopillar structures, effectively increasing the light trapping in the nanopillars (Fig. S1).

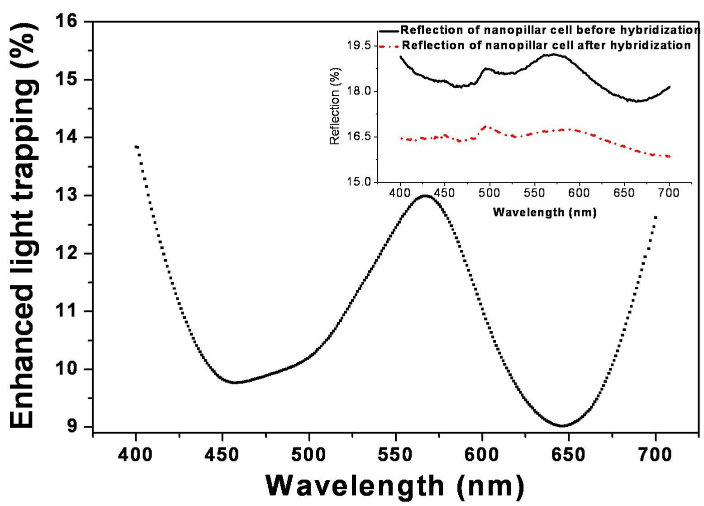

Figure S1. Increased light trapping of the nanopillar solar cells after the quantum dot hybridization, along with reflection spectra of the nanopillar cells before and after the hybridization shown in the inset.