The emitted 442-nm wavelength blue light would be produced via the exciton recombination process at the Cd$_{0.5}$Zn$_{0.5}$S core QD and the red shift induced by the compressive strain at the interface between the Cd$_{0.5}$Zn$_{0.5}$S core QD and ZnS shell QD. In order to understand this, we estimated the interfacial strain depending on core QD and shell QD materials. The interfacial strain of Cd$_{0.5}$Zn$_{0.5}$S/ZnS core/shell QD was calculated by using the references presenting the lattice constants of the Cd$_{0.5}$Zn$_{0.5}$S core and ZnS shell QD, indicating a compressive strain of ~4.02%, as shown in Table 1. In addition, the energy band-gap of the Cd$_{0.5}$Zn$_{0.5}$S core QD was calculated by using the Vegard’s law, given by

$$\alpha_{Cd_xZn_{1-x}S} = x\alpha_{CdS} + (1-x)\alpha_{ZnS}$$

$$E_{g,Cd_xZn_{1-x}S} = xE_{g,CdS} + (1-x)E_{g,ZnS} - b(1-x)$$

where $\alpha_{Cd_xZn_{1-x}S}$, $\alpha_{CdS}$, $\alpha_{ZnS}$ are the lattice parameters of Cd$_x$Zn$_{1-x}$S, CdS, ZnS and $E_{g,Cd_xZn_{1-x}S}$, $E_{g,CdS}$, $E_{g,ZnS}$ are band gap of Cd$_x$Zn$_{1-x}$S, CdS, ZnS and $b$ is the band gap bowing parameter of the Cd$_x$Zn$_{1-x}$S. The calculated band gap of the Cd$_{0.5}$Zn$_{0.5}$S core QD is 2.85 eV at 0.45 eV of band gap bowing parameter, which will emits a PL peak at 435-nm in wavelength.$^1$ However, the measured
PL (emitted blue light) of the Cd$_{0.5}$Zn$_{0.5}$S/ZnS core/shell QD peaked at 442-nm in wavelength, corresponding to ~2.81eV. This wavelength difference (a red shift of ~ 7nm) would be originated from the interfacial compressive strain. Therefore, the 442-nm wavelength blue light was emitted by the red shift induced by the interfacial compressive strain from the electron-hole recombination at the energy band gap of the Cd$_{0.5}$Zn$_{0.5}$S core QD (2.85 eV).

Supplementary Figure 1. Dependency of optical properties on the growth time of the ZnS shell in Cd$_{1-X}$Zn$_X$S/ZnS core/shell QDs. (a) Diameter of Cd$_{1-X}$Zn$_X$S/ZnS core/shell QDs calculated by observing TEM images, (b) Absorption spectrums and PL peaks, and (c) Emitted PL wavelength and quantum yield.
Supplementary Figure 2. Effect of the SiNₓ anti-reflective film thickness on EQE and J_{SC}. (a) EQE as a function of wavelength and (b) TEM images as a function of the SiNₓ anti-reflective film thickness.
Supplementary Figure 3. Photovoltaic performance for the flexible ultra-thin silicon solar-cells, flexible ultra-thin silicon solar-cells with SiN\textsubscript{X} anti-reflective film, and flexible ultra-thin silicon solar-cells with SiN\textsubscript{X} reflective film and Cd\textsubscript{0.5}Zn\textsubscript{0.5}S/ZnS core/shell QDs. (a) $J_{SC}$, (b) $V_{OC}$, (c) FF, and (d) PCE by the average (point), maximum (higher bar) and minimum (lower bar) among six samples.
Supplementary Figure 4. Bending fatigue performance for flexible ultra-thin silicon solar-cells, flexible ultra-thin silicon solar-cells with SiN\textsubscript{X} anti-reflective film, and flexible ultra-thin silicon solar-cells with SiN\textsubscript{X} anti-reflective film and Cd\textsubscript{0.5}Zn\textsubscript{0.5}S/ZnS core/shell QDs. (a), (b) and (c) $J_{SC}$ and $V_{OC}$, (d),(e), and (f) FF and PCE as a function of bending cycles.