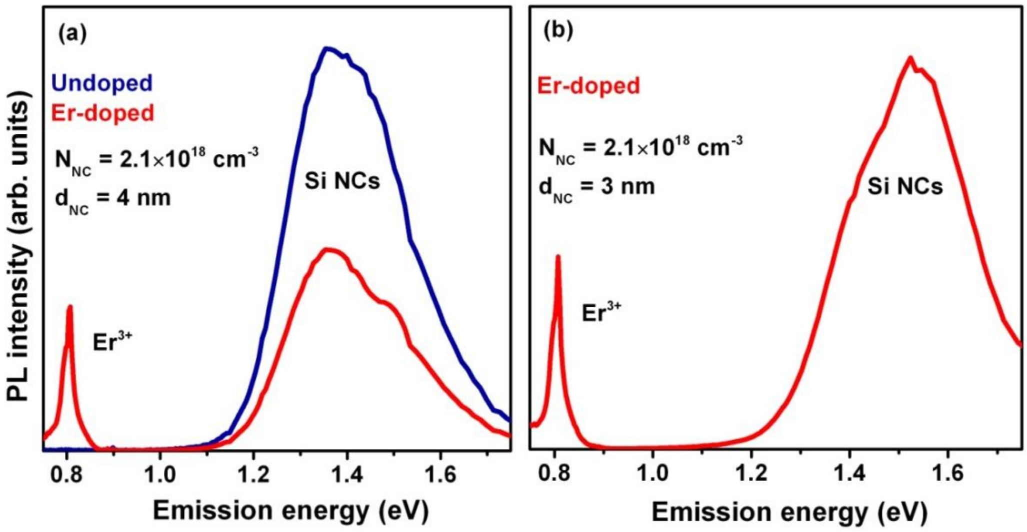
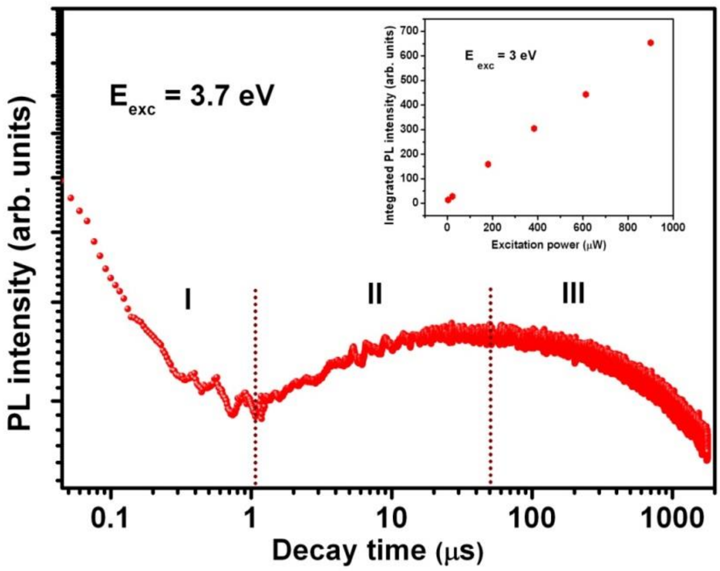
Supplementary Information

Supplementary Figures



Supplementary Figure 1 PL spectra of Er free and Er doped material (**a**) PL spectra for undoped (blue) and Er-doped (red) samples with NC diameter of d_{NC} = 4nm. Si NC-related PL can be seen around 1.4 eV for both samples. For the Er-doped sample, Er-related PL can be seen at 0.8 eV, in addition to Si NC-related PL, whose intensity is quenched upon introduction of Er^{3+} ions. (**b**) Si NCs- and Er-related PL for the sample with a Si NC diameter of d_{NC}= 3nm. Due to different size of the Si NCs, the emission band is now centered around 1.5 eV.



Supplementary Figure 2 PL lifetime of Er emission. Double logarithmic representation of the Er-related PL decay showing contributions of the two excitation mechanisms: the "fast" one mediated by hot carrier cooling, as discussed in the paper (range I, $t \leq 1$ μs), and the "slow" excitonic one (range II and III, $t > 1$ μs). The inset shows the power dependence of the Er PL for excitation at 3 eV.

Supplementary Methods

Scaling different detection systems

Two different detection systems were utilized to determine the external quantum yield (EQY) of Er-related photoluminescence (PL). A CCD (λ_{det} = 200-1100 nm)was used to record the excitation spectra whereasinfrared emission of Er^{3+} ions was recorded using a Ge detector (λ_{det} = 900-1700 nm). Since two different detection systems were used, the efficiencies of the two detectors needs to be scaled. For this purpose, firstly the correction curves were determinedfor both systems using tungsten-halogen and deuterium lamps. To overlapthe detection range of the two detectors, Si NCs dispersed in ethanol with emission range of 700-1100nm were used. After measuring the PL spectra of this sample with both detectors, the spectra were first corrected for spectral sensitivity by making use of the correction curves and then properly scaled. This scaling factor was later used to correct all the calculations done for the determination of EQY of Er-related PL. Another important factor is that the EQY calculated for Er-related PL was a relative measurement since the integrated PL signal at 0.8 eV was used instead of actual number of emitted photons at 0.8 eV. To convert this number to an absolute number we measured the EQY of the same sample mentioned abovemaking use of two methods i.e: relative (two detection system) and absolute (single detection system). Here we get another scaling factor and this scaling factor was then used to convert the relative number to an absolute number.