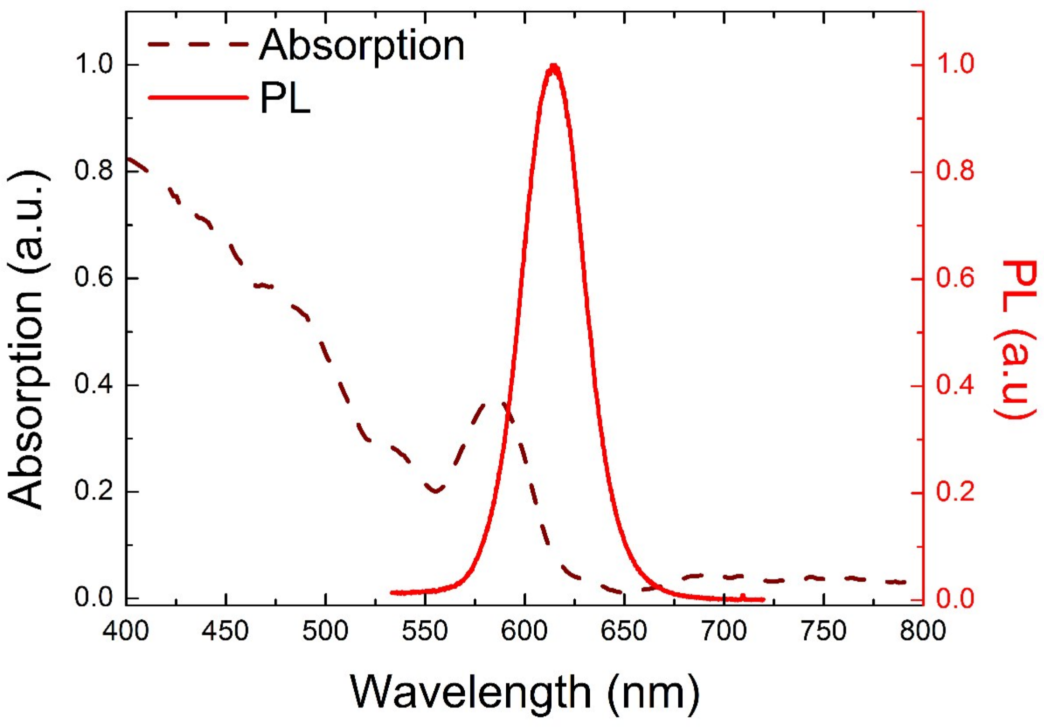
Supplementary Information

1. Optical properties of CQD film

- Photoluminescence and absorption

The range of emission wavelengths can be identified by a simple photoluminescence measurement on CQD film. Suppl. Figure 1 shows the photoluminescence data measured from planar region (CQD film only on a planar part, without underlying PC pattern) of T-130. The CQD photoluminescence peak, which is centered at λ ~ 615 nm with emission bandwidth of ~ 50 nm in FWHM, is the tuning target for photonic band-edge modes. Shown together in the figure is the absorption coefficient of the CQD film ($\alpha = 4\pi k/\lambda$), which is converted from the imaginary part of refractive index, $n(\lambda)$-$ik(\lambda)$, obtained from spectroscopic ellipsometer measurement.



Suppl. Figure 1 Measured photoluminescence and absorption coefficient spectra of CQD film.

- Photoluminescence quantum yield

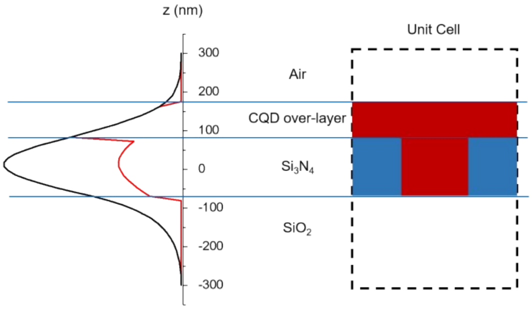
Photoluminescence (PL) quantum yield (QY) can be obtained by measuring the absorption and photoluminescence spectra of the CQDs, and subsequently comparing them with those of Rhodamine 640 dye, which is known to have a near 100% PL QY. Detailed PL QY estimation is described in (J. Am. Chem. Soc. 124(9), 2049-2055, 2002). From the ratios between the two materials, CQDs and Rhodamine 640, in absorption strength and integrated PL intensity, we have estimated the PL QY of our CQDs to be ~75±5%.

2. Modal gain and confinement factor

Pure material gain *g* of CQDs depends on the level of optical excitation—optical power of pump beam. When it comes to a specific photonic structure such as laser cavity, however, one has to consider the optical overlap of a structurally supported resonant mode with gain material, leading to the term "modal gain" defined by Γg, where the confinement factor Γ for a given mode is expressed as

$$\Gamma = \frac{Light\ intensity\ in\ the\ active\ layer}{Total\ light\ intensity} \sim \frac{\int_{active} |E|^2}{\int_{V} |E|^2}.$$

We have evaluated the confinement factor for M-point band-edge modes supported by T-130 and T-80 samples. In our case, gain material in a unit cell has two parts: CQD-filled cylinder and CQD over-layer as depicted in Suppl. Fig. 2, which consist of the volume over which the integration in the numerator is to be done. Also shown in the figure are the intensity profiles of the guided mode and the effective guided mode (after taking into account the modal overlap with gain material). Calculated optical confinement factors are listed in Suppl. Table 1.



Suppl. Figure 2 An example of optical confinement calculation for the LIB mode of T-80 sample. Black line indicates the total intensity profile of the guided mode, and red line is the effective guided mode intensity profile, which is obtained by taking into account the areal ratio of gain material (CQD) at a given z-coordinate.

	T-80	T-130
LIB band-edge mode	0.392	0.428
HIB band-edge mode	0.281	0.325

Suppl. Table 2. Optical confinement factors calculated by FDTD method

Assuming that optical gain g is uniform across CQD films, modal gain Γg is directly proportional to the confinement factor itself. Then the modal gains of T-130 are higher than T-80 for both the HIB and LIB band-edge modes, which is consistent with the lower laser thresholds for T-130. In addition, the fact that LIB band-edge modes have higher modal gain values than HIB band-edge modes explains why the thresholds of LIB band-edge modes are lower than those of HIB modes, regardless of the CQD over-layer thickness.