

Supplementary Information

As shown in our previous work³⁷, biexciton photoluminescence (PL) quantum yields (QY_{2X}) for 19 ML g-NQDs may reach large values, up to $QY_{2X} \approx 0.9$. Biexciton emission appears in the PL dynamics as a fast initial component with the amplitude, which is proportional to QY_{2X} and the biexciton population at a given pump power. Fig. S1 shows a set of data, similar to the one in Fig. 3 for a 19 ML g-NQD, which has large QY_{2X} of 0.67 as measured via photon correlation and independently confirmed by the PL intensity saturation approach (Ref. [37]). The PL dynamics measured even at the lowest excitation power ($\langle N \rangle = 0.6$) show a pronounced fast component at early times. The probability of populating the N -exciton state at a particular average NQD occupancy, $\langle N \rangle$, is given by

the Poisson distribution function, $P(N, \langle N \rangle) = \langle N \rangle^N \frac{e^{-\langle N \rangle}}{N!}$. According to this expression, for $\langle N \rangle = 0.6$ there is ~30% chance ($\frac{\sum_{N=2}^{\infty} P(N, \langle N \rangle)}{\sum_{N=1}^{\infty} P(N, \langle N \rangle)}$) for a multiexciton

recombination event to occur. If we assume that the slow decay constant $\tau_1 = 104$ ns at $\langle N \rangle = 0.6$ represents the radiative decay time of a single exciton and that the N -exciton radiative decay time scales with N as τ_1/N^2 and further account for the QY_{2X} of 0.67, we obtain that the total decay time of a biexciton is 17 ns. This is in an excellent agreement with the measured fast decay constant of ~15 ns. The resulting simulated curves are shown by the dashed black lines in Fig. S2C together with the measured PL traces (red lines). Good agreement between the simulated curves and the experimental data confirms the validity of our explanation of the initial fast component in terms of multiexciton emission in some of these g-NQDs.

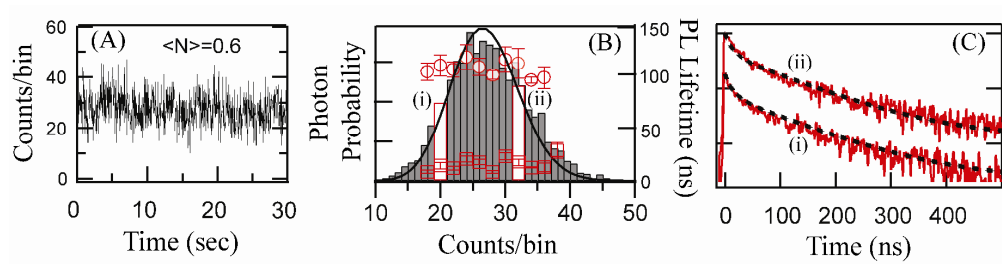


Figure S1. (A) PL intensity trajectories, (B) PL intensity histograms and (C) PL lifetimes for a 19 ML dot with $QY_{2X} \approx 0.67$. Dashed lines are modeled based on the multiexciton picture as discussed in Suppl. Info.