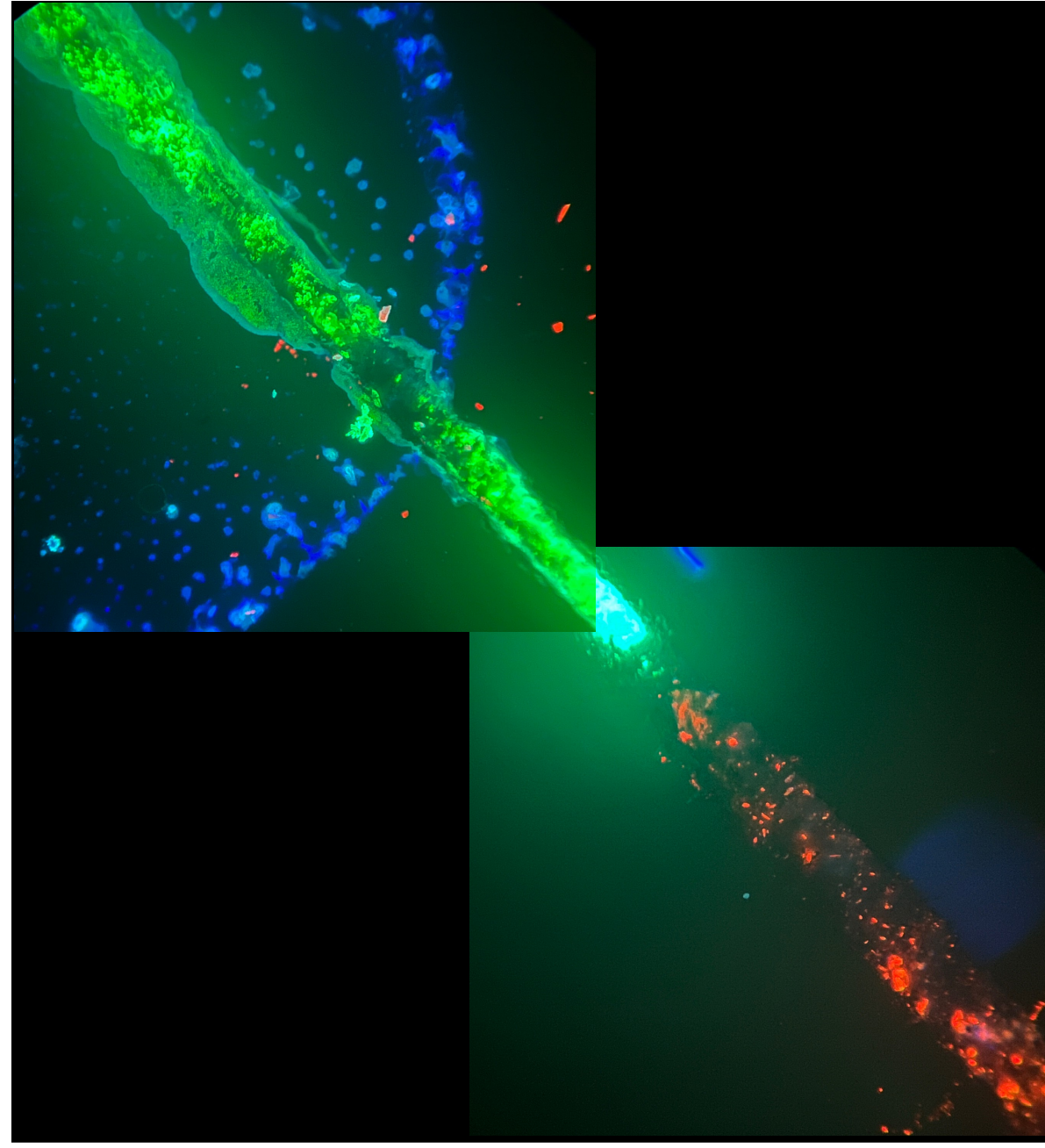


## I. Introduction

Silicon-perovskite tandem solar cells are some of the most promising leading emerging technological designs due to their high power conversion efficiencies. We have ample data confirming the dependence of the photoluminescence quantum yield (PLQY) of metal halide perovskite nanostructures grown inside a porous silicon (pSi) template on the properties of the template itself.<sup>2</sup> This has led us to examine the fundamental interactions occurring when nanoscale silicon particle encounters a metal halide perovskite nanostructure, namely the possibility of energy/charge transfer.

Luminescent microporous silicon can ideally be used as a probe of this interaction due to its visible light emission near 650 nm which allows the monitoring of interactions between cesium lead tribromide (CsPbBr<sub>3</sub>) QDs and the silicon via steady-state/time resolved photoluminescence (TRPL) spectroscopy. Here we focus on the use of non-luminescent mesoporous silicon as a model system in quenching experiments monitoring the emission of the MHP nanocrystals as silicon is added to the sample.



**Figure 1.** Image of luminescent pSi (red-orange) interacting with QDs (blue) on a glass slide. A channel was cut into the slide and the QDs allowed to flow toward the pSi shifting the emission of the QDs to the green.

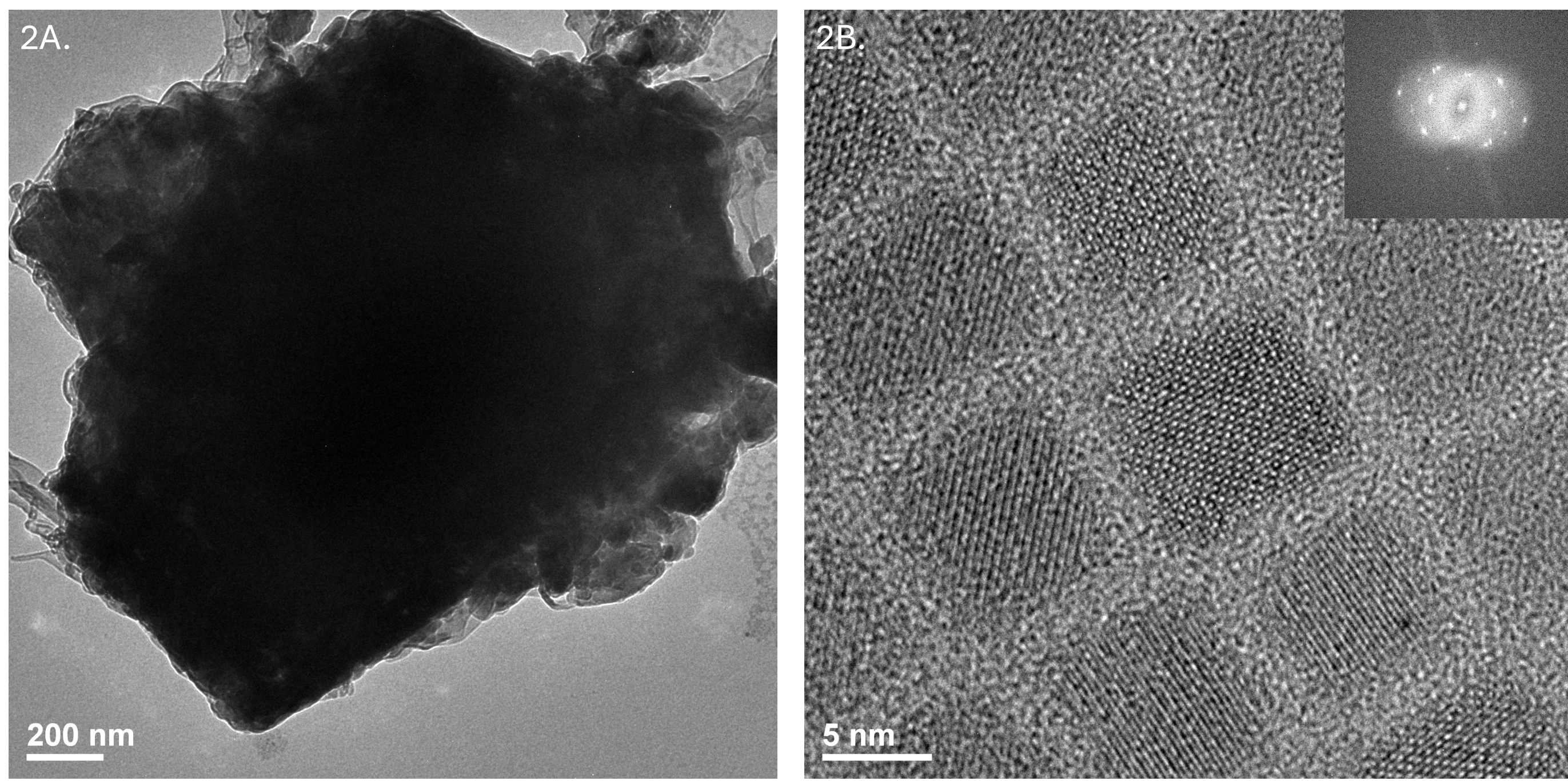
## II. Materials and Methods

### A. Porous Silicon

- pSi fabricated by anodization in hydrofluoric acid
- Mean particle size of 20 micrometers.
- Surface area to be 275m<sup>2</sup>/g and pore size of 11.5nm.
- Oxidized pSi was oxidized at 800 C for 1 hour.

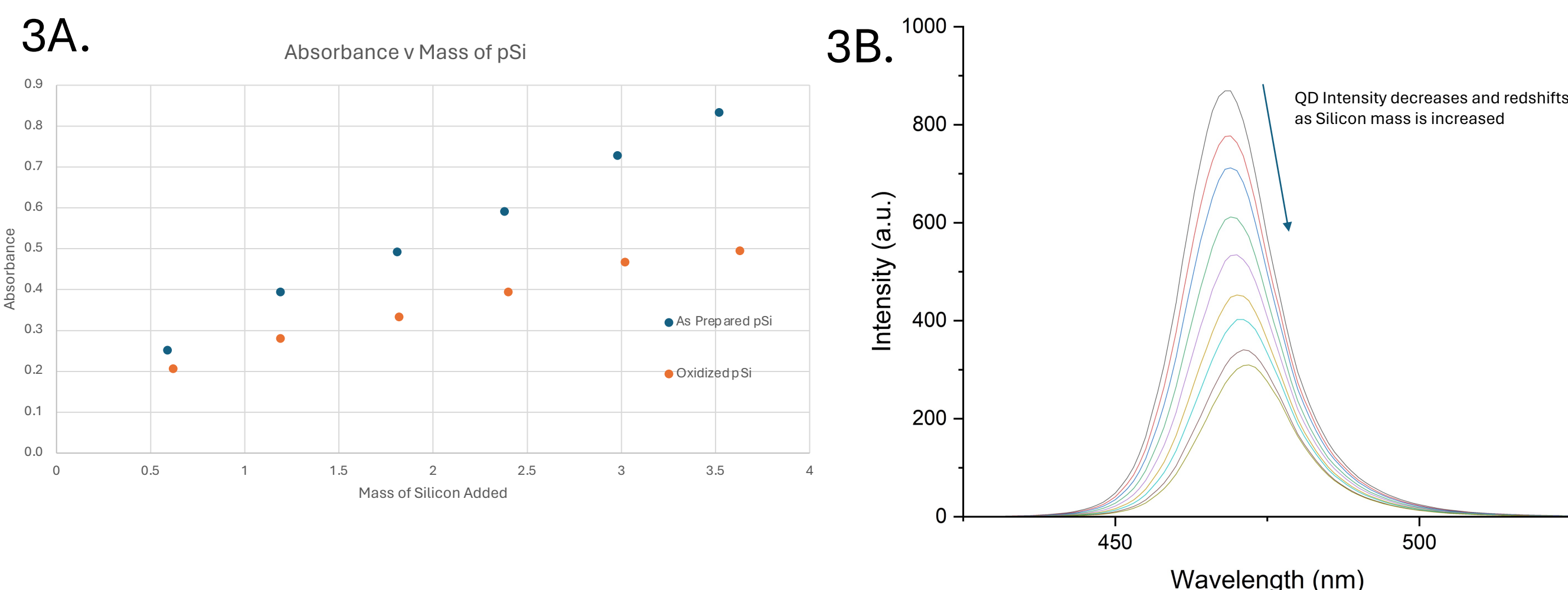
### B. Perovskite Quantum Dots

- Purchased from Sigma-Aldrich
- Composed of CsPbBr<sub>3</sub>
- Emission wavelength of 510nm
- Average size 7.8nm



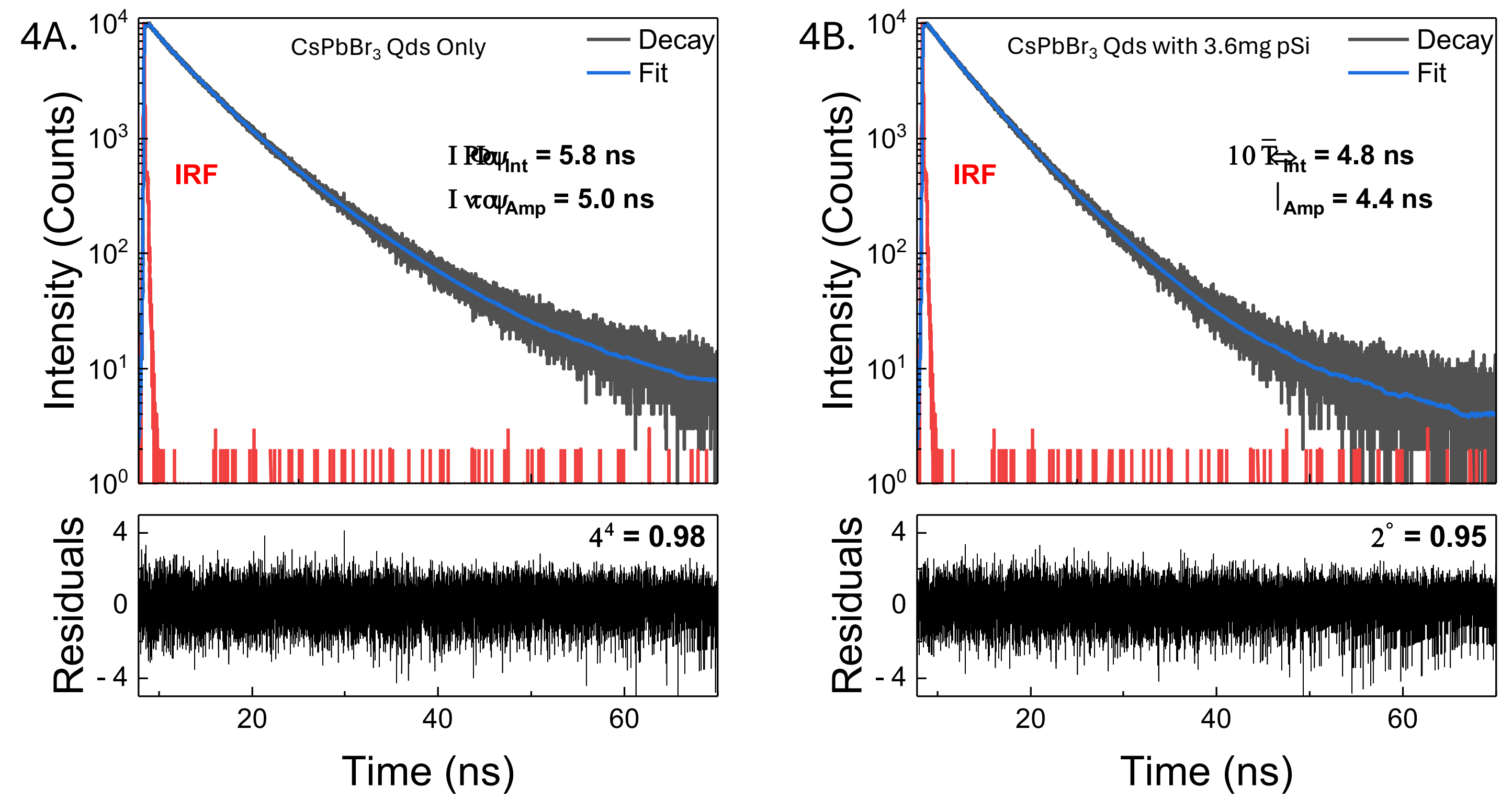
**Figure 2A.** TEM image of a pSi particle with size of 3 micrometers. **2B.** TEM image of a perovskite quantum dot superlattice with individual dots stacked next to each other with oleic acid/oleylamine creating the light-colored space between. QDs average 7.5nm in length.

## III. Results

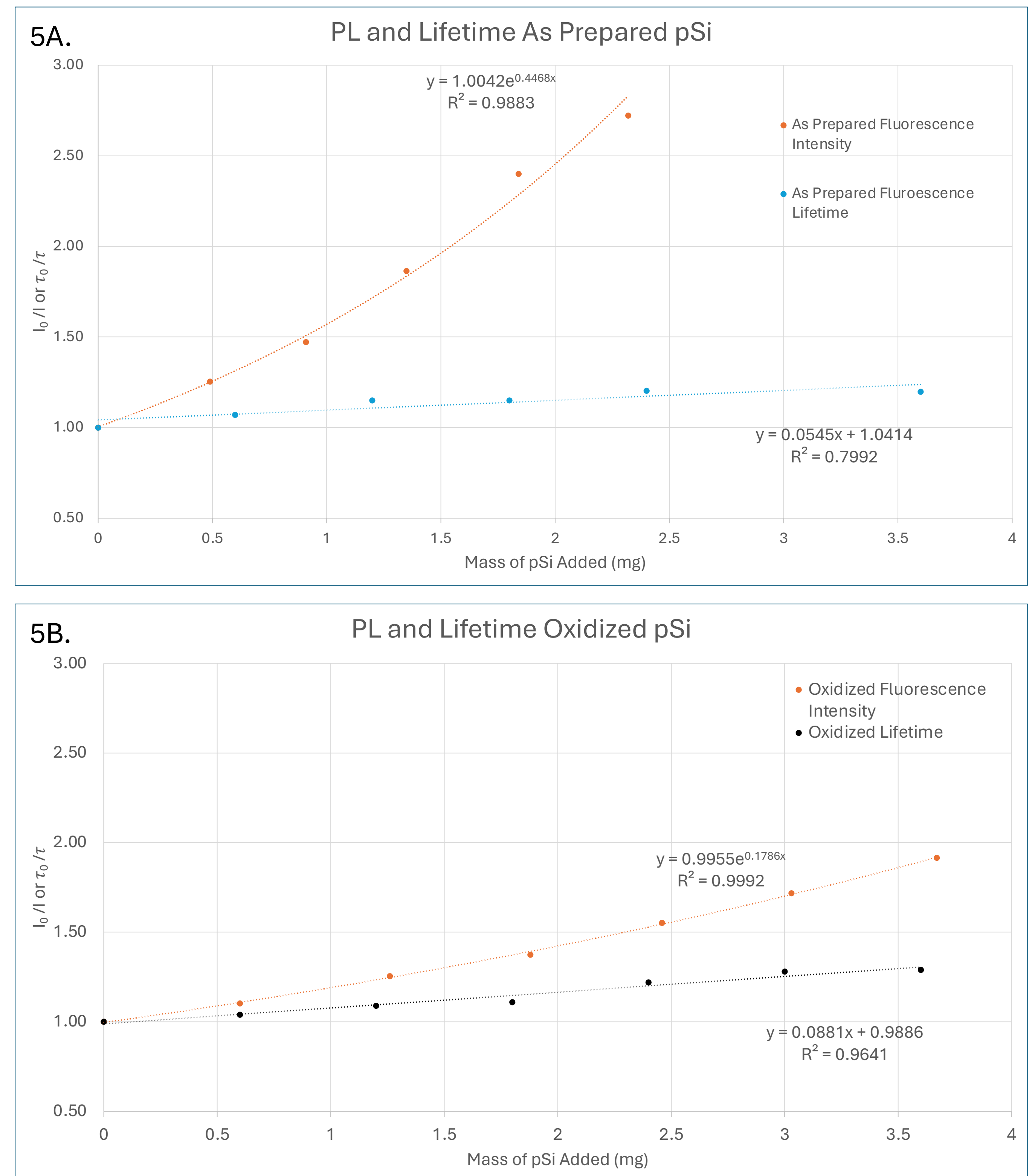


**Figure 3A.** Absorbance vs mass of pSi added to the system. **3B.** Representative PL spectrum of 480nm QDs showing a decrease in PL as more pSi is added to the system. The PL emission maximum redshifts as more pSi is added to the system as well.

## III. Results Cont.



**Figure 4A.** TRPL measurements with 375nm excitation and monitoring 510nm emission. QD lifetimes of 5.8ns intensity weighted and 5.0ns amplitude weighted. **4B.** QD +pSi lifetimes of 4.8ns intensity weighted and 4.4ns amplitude weighted showing a decrease in lifetime.



**Figure 5A/B.** PL intensity ( $I$ ) plotted as  $I_0/I$  as a function of mass of pSi added to the system according to the Stern-Volmer relationship. TRPL ( $\tau$ ) plotted as  $\tau_0/\tau$  as a function of pSi added to the system.  $I$  is fitted to an exponential function according to the Stern-Volmer relationship showing a mixture of static and dynamic (collisional) quenching effect for both types of porous silicon. The rate of decrease in fluorescence is much less for the oxidized pSi according to the exponential function.

## IV. Conclusions

The addition of pSi to metal halide perovskite QDs quenches the emission of the QDs. This quenching can be attributed to energy transfer from the QD to the porous silicon in both a static and dynamic collisional model based on the fitting of the PL and TRPL lines/curves. The change in quenching rate between the as prepared and oxidized porous silicon can be attributed to both changing of the surface chemistry and morphology. It is known that oxidation of porous silicon reduces both the pore size and the surface area which prevents the quantum dots from interacting with the pSi thus reducing the quenching rate of the oxidized material.

## V. References

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