The Surface Chemistry of Quantum Dots

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1 Quantum Dots

Quantum dots (QDs) are all around us!
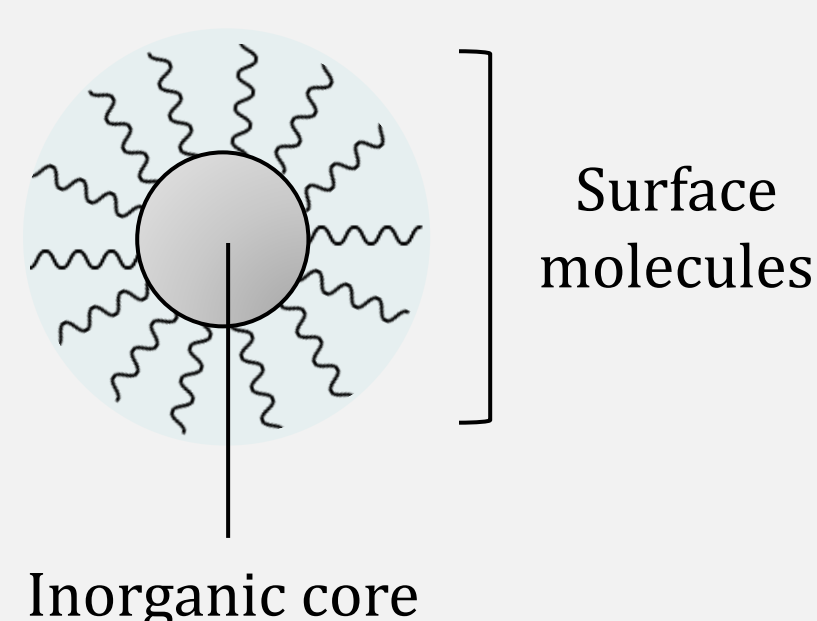

QLED displays   Solar panels   Facial recognition

Quantum dots are nanoscale semiconductor crystals whose properties depend on their size.

What can we do to enable more control over QD properties?
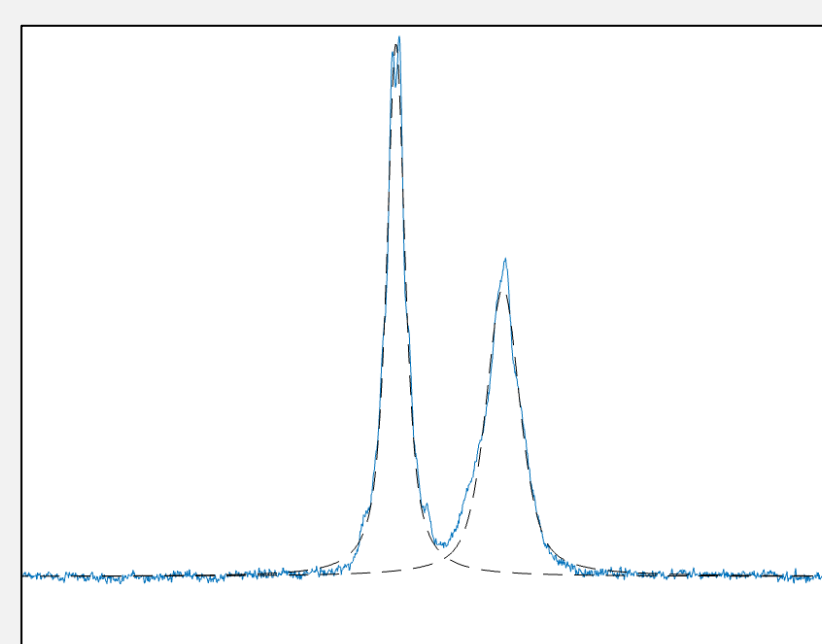
Quantum Dot Structure

Surface molecules

Inorganic core

Study the surface of QDs
↓
Develop effective methods for replacing surface molecules
↓
Create a higher-performing material

2 Experimental Work

1. Synthesize quantum dots

Separate the QDs from the solvent **(two methods)**   Exchange the surface molecules **(two methods)**

hot injection   QDs

2. Gradually add either the original or new surface molecules

QDs   ...

3. Monitor the behavior using magnetic resonance spectroscopy

Typically, the left peak corresponds to the original molecule and the right peak corresponds to the new molecule.

3 Data Analysis

We use mathematical modeling in MATLAB to fit the peaks observed in the experiments.

- **Peak area**: corresponds to the quantity of the molecule of interest.
- **Peak position**: often indicates how strongly the molecule is bound.

The developed code helps analyze the data more efficiently, offering valuable insights into the dynamics of the system.
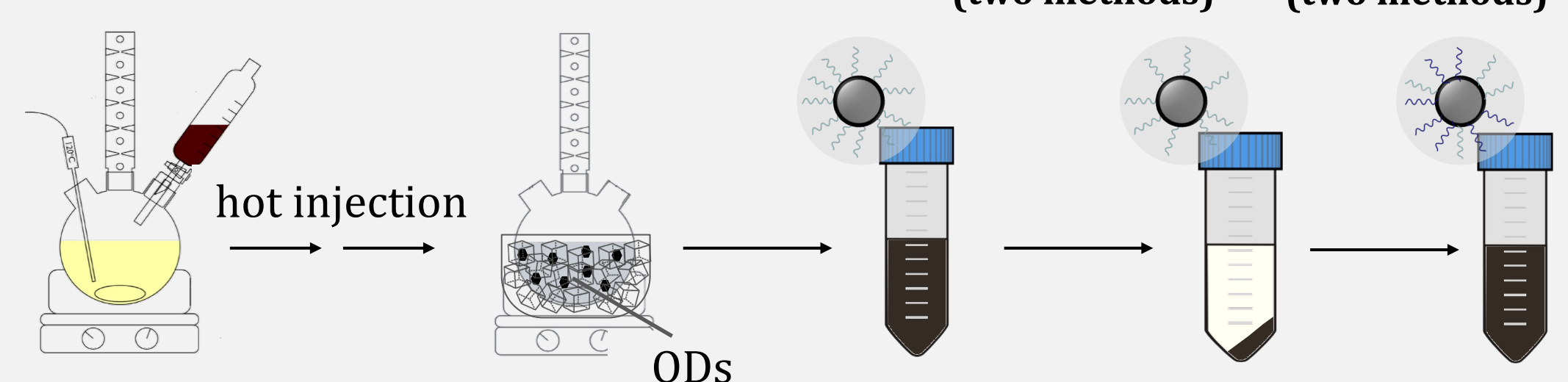
4 Takeaways & Outlook

The insights from the data analysis using the developed code help us evaluate how well the molecule exchange process works and improve the experimental methods. The results of this project aim to improve molecule exchange techniques for customizing QD surfaces, which could lead to better material designs and expanded technological uses.
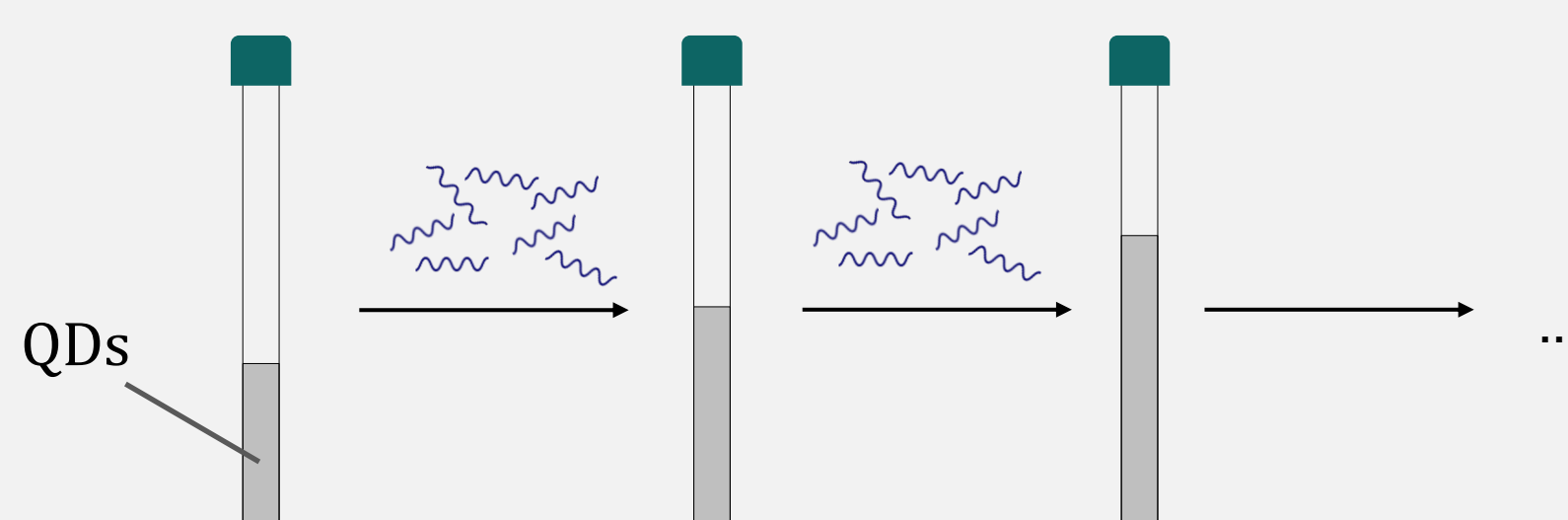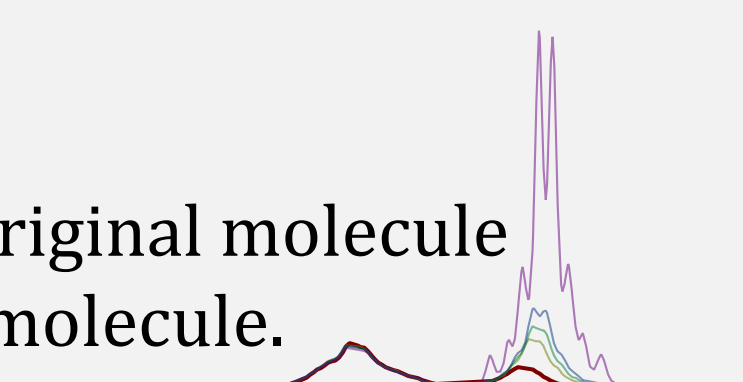
During the project, I had the chance to develop my computational skills and apply them to a well-defined research problem. I also connected with graduate students and postdoctoral researchers at MIT Chemical Engineering and received valuable career advice. Additionally, I improved my science communication abilities by presenting my work to audiences with different levels of expertise.

5 Acknowledgements

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Let's Connect!

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