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Methods for Bioconjugation of Biochemical Sensors based on Metallic Nanoparticles

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Background and Introduction

- The purpose of this experiment was to determine the effect of different conjugation methods on quantum dot uniformity. The traditional method of bathing a sample in the conjugation chemicals was compared to the newer flow method.
- Quantum dots (Qds) are nanocrystals that are alternatives to fluorescent dyes used in optics. Qds have molecules on their outer shell that can be indirectly adsorbed into gold nanostructures on glass slides (Fig 1.)
- Previous experiments have used a flow chamber as the method to conjugate Qds to gold. These experiments offered promising results, but the flow method allows only one sample to be conjugated at a time.
- The bath method allows multiple samples to be created at once, increasing conjugation efficiency.

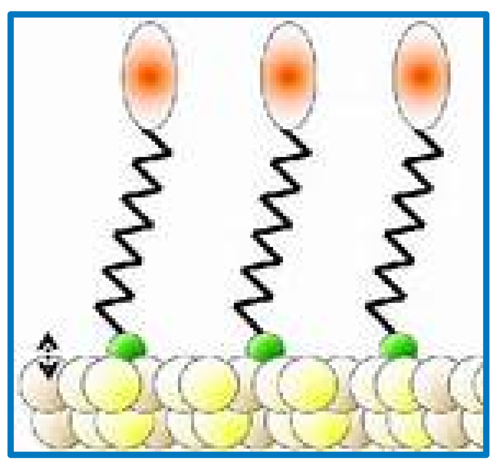

Fig 1. Quantum Dots indirectly attached to gold nanostructures

Methods

- 10nm of Gold and 2 nm of Chromium were deposited through sputtering onto a glass slide
- A mixture of sulfur containing molecules were either flowed over the sample, or poured onto the sample for 1-2 days
- EDC/NHS was either flowed (Fig 2.) over the sample or stirred over the sample to activate carboxyl groups on the sulfur containing molecules
- The samples were bathed in Qds for 30 minutes
- Control Samples were created by only bathing the sample in Qds for 30 minutes
- An EMMCD camera was used to image the samples after the Qds were conjugated to determine quantum dot uniformity.
- The Standard deviation of each images total pixel values was taken as a measure of uniformity

Fig 2. Flow Chamber containing Gold Nanostructures on a Glass Slide

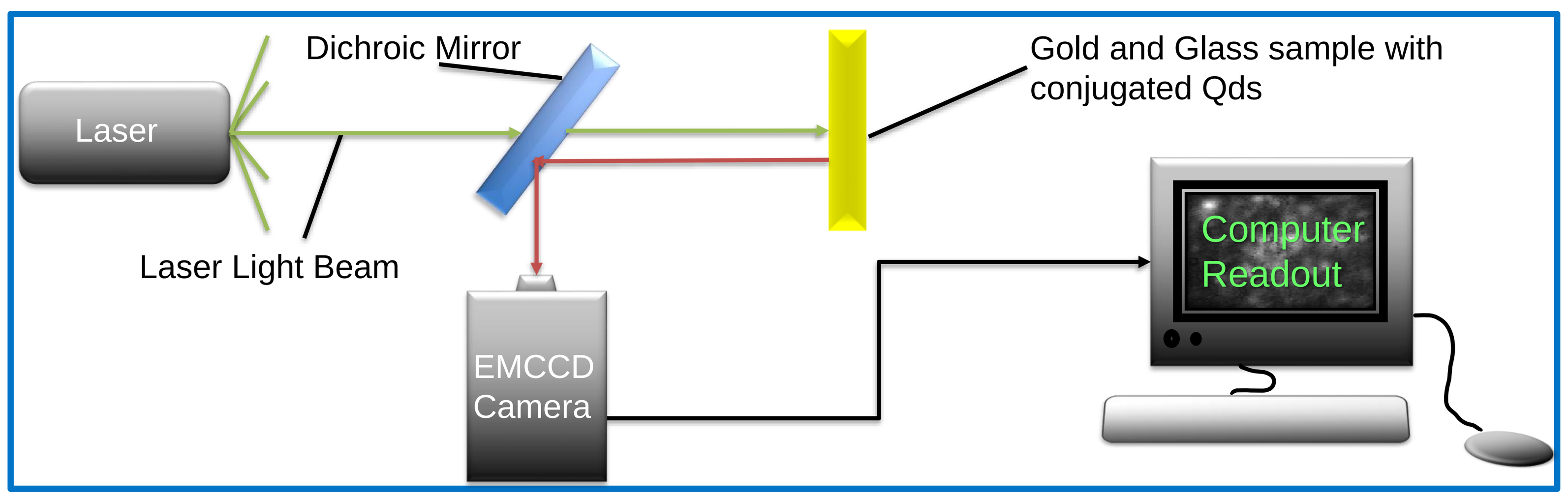

Fig 3. Displays the layout of the EMCCD camera setup used to image the samples

Results

- There appeared to be no significant difference in the uniformity of Qds across flow and bathing methods
- The gold in the first flow sample lifted from the sample in gold flakes in the EDC/NHS step. This was prevented in the second sample by stirring the EDC/NHS in a petri dish containing the sample, and by using a sample also containing a chromium adhesive layer beneath the gold
- Fig 3. (a) and (b) show the standard deviations of each EMCCD camera's image compared between each sample.

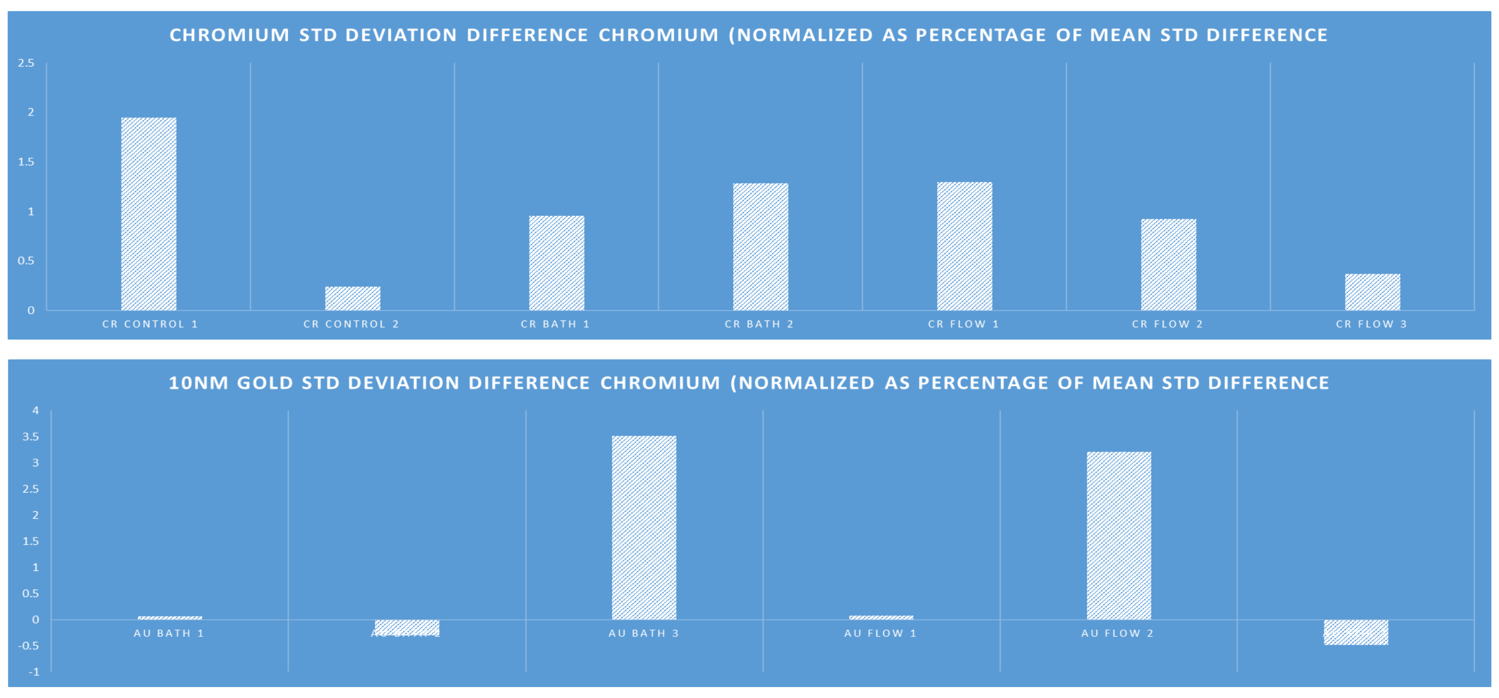

Fig 3a. (top) shows the standard deviation comparisons between each sample containing a 2nm chromium adhesive layer. Fig 3b. (bottom) displays the standard deviation differences across the samples containing only a 10nm layer of gold. All figures have been standardized as percentages of their mean sample group's standard deviation difference.

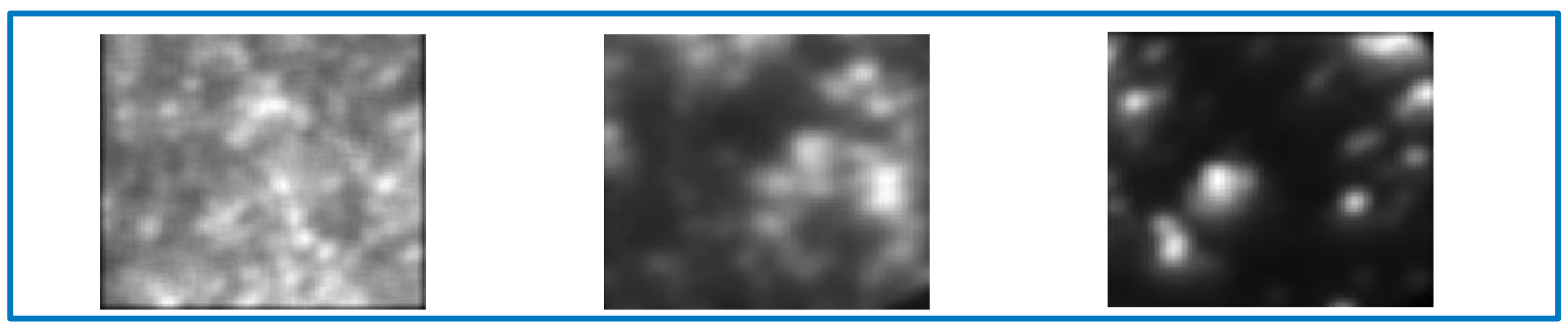

Fig 4 displays EMCCD images in order of uniformity. The uniformity decreasing from left to right.

Impact and Conclusions

- This work utilizes cheap amine quantum dots to make a uniform covering of Qds across a region of glass nano islands
- This study also displays that using the flow method for Qd conjugation has no significant effect on the uniformity of Qds across a nano island sample
- Using the bathing method, multiple samples can be created simultaneously instead of the single sample that can be created with the flow chamber
- Due to the small number of controls, the effect on uniformity of the SAM can not be determined, which will require future trials.

Acknowledgements

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