Sub-diffraction Quantum Dot Waveguides

UWEE Photonics

Jean Wang
Funder NSF Graduate & Intel Ph.D. Fellowships
Affiliation Electrical Engineering
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Finding a way to guide light within 100's of nm width while reducing loss.

Motivations:

** Realizing ultra-high density photonic integrated circuits requires guiding light at sub-diffraction limit dimensions without extensive loss from sharp bends.

** Harness inherent advantages of large bandwidth, capacity and high speed modulation in optical communication at the sub-micrometer scale.

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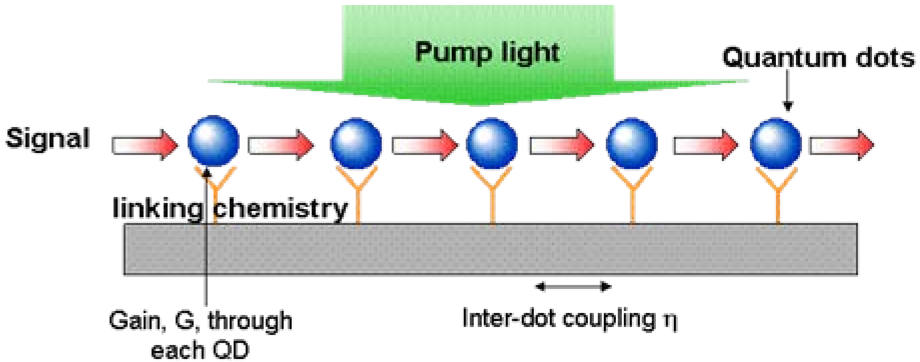
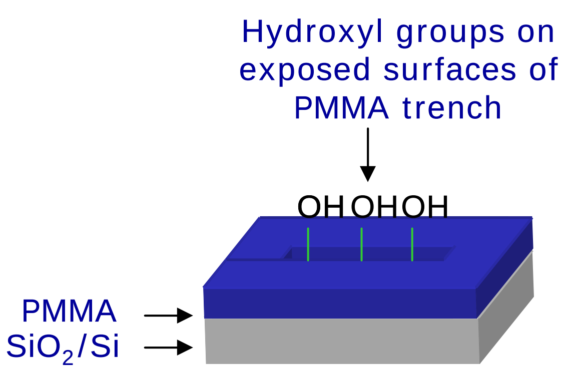
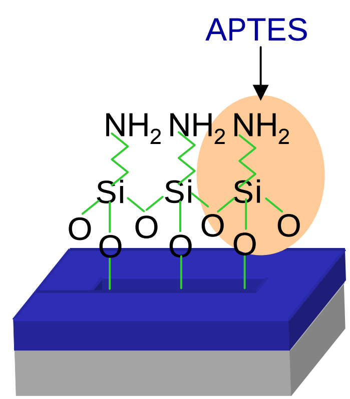
Operation & Fabrication



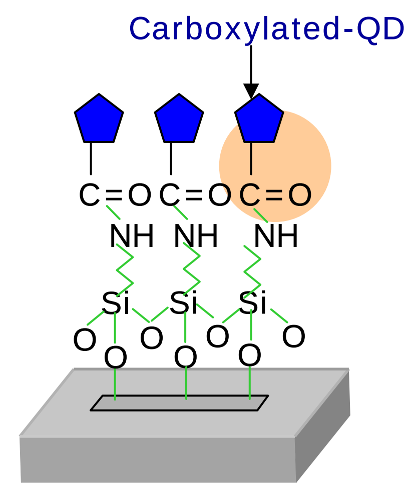
- Gain generated by pump light
- Stimulated emission by signal light
- Optical propagation by energy transfer, characterized by inter-dot coupling efficiency η



- Spin-coat PMMA
- E-beam lithography
- Develop PMMA
- O_2 plasma treatment



- Form 3’aminopropyl-triethoxysilane (APTES) monolayer



- Covalently bind carboxylated-QDs via EDC, 1-ethyl-3-(3 dimethyl-aminopropyl)-carbodiimide
- Remove PMMA with dichloromethane

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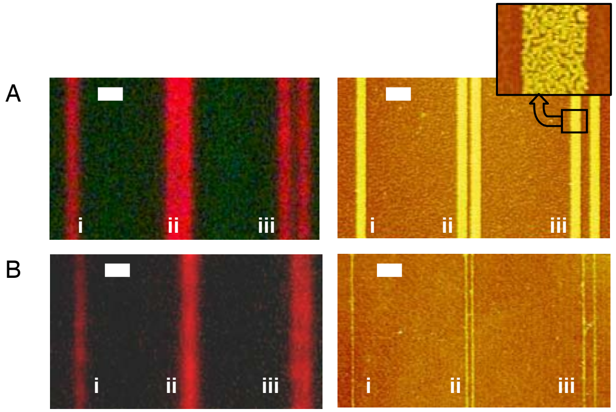
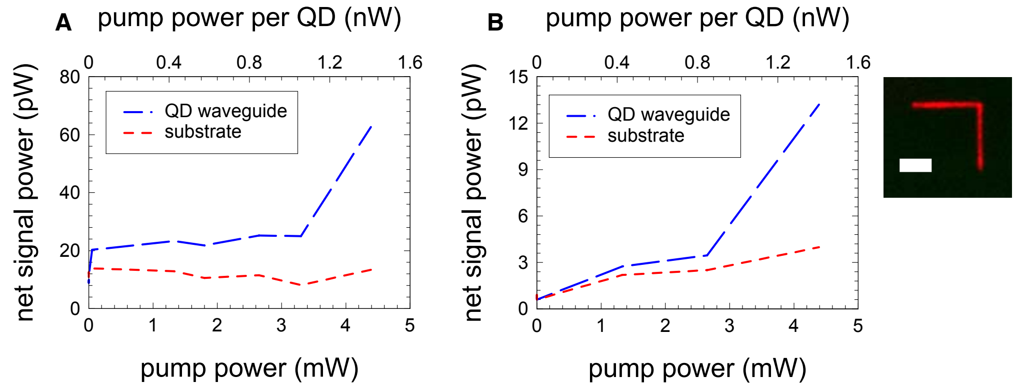
Results & Continuing Work



Fluorescence and corresponding AFM of (**A**) 500 nm with inset depicting granular QD shape and (**B**) 100 nm wide waveguides in (i) single and pair formations spaced (ii) 200 nm and (iii) 500 nm apart. Scale bar is 1 µm in length.



Measured transmission results from 500 nm width waveguides demonstrating higher signal on the waveguide than on substrate. (**A**) 10 µm straight waveguide net signal power and (**B**) 10 µm x 10 µm corner net signal power.

- Gain mechanism in QD combined with high inter-dot coupling coefficient enable efficient energy transfer
- Demonstrated fabrication via two-layer self assembly with sub-diffraction limit dimensions
- Preliminary test results of sub-diffraction limit devices
- Testing permutations: distance, crosstalk, cornering
- Test multi-QD type devices for crosstalk

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