Synthesis and Optical Properties of Organic DAAQ Nanowires

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

William Lowery[1,2], Bibek Dhami[1], Ravi Tripathi[1] and Kannatassen Appavoo[1]
[1] Department of Physics, University of Alabama at Birmingham, AL 35233
[2] Chemistry, University of Montevallo, Montevallo, AL 35115

MOTIVATION

Nanoscale components are becoming more ubiquitous as society reduces the size of its optoelectronics devices such as sensors and LEDs.

Fig 1. *An example of fiber optic wires*

Nanophotonics hopes to bridge the size gap between electronics and fiber optics and include applications such as:

- Lasers
- Fiber optics
- Solar cells
- Sensing

Nanophotonics is the study of optics at the nanoscale (10^{-9} m). This represents less than the width of a hair!

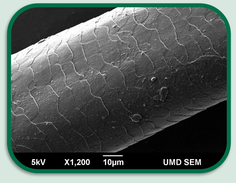


Fig 2. *A human hair*

BACKGROUND

Our goal is to make and characterize optical nanowires. While similar achievements have been made with inorganic nanowires, little has been reported for organic based ones. These organic based nanowires are theorized to be more readily synthesizable and should hold interesting properties due to their different intermolecular forces.

Our nanowires will be made from the organic dye 1,5-diaminoanthroquinone (DAAQ). DAAQ nanowires are easy to fabricate and have absorption and emission features in the visible region.

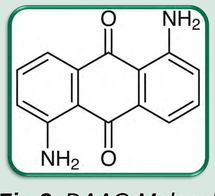


Fig 3. *DAAQ Molecule*

EXPERIMENTAL

Part I: Preparation of Substrate

- In order to locate specific nanowires within a 1x1 inch^2 area and map its properties, a mask was created.
- Fabricated with 3D printing techniques with ABS.
- Mapping grid obtained after sputter coating a normal glass slide with a metallic coating

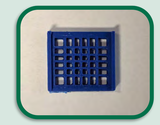


Fig 4. 3D printed mask

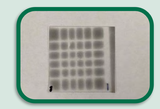


Fig 5. Masked slide after coating

Part II: Synthesis of Nanowires

- Dissolve DAAQ in ethanol
- Rotary evaporate to obtain uniform layer
- Suspend substrate in flask and heat to approximately 160° C for 45-60 mins.

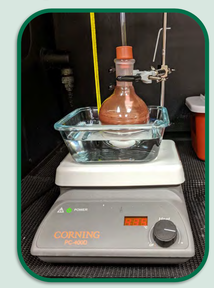
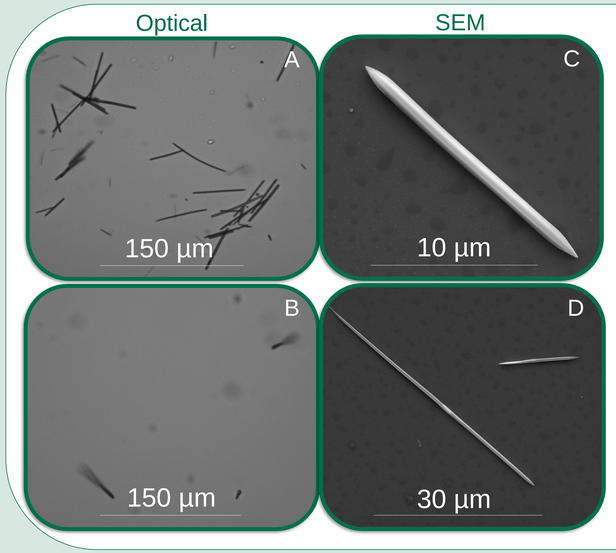


Fig 6. Experimental setup

Part III: Optical Characterization

- Optical and Scanning Electron Microscope (SEM) imaging



RESULTS

Fig 7. Images of DAAQ Nanowires. (A) showcases the glass substrate at 40x whereas (B) shows the gold/palladium coating.

Horizontal Growth in (A)

Vertical Growth in (B)

Pointed Ends in (C) & (D)

DISCUSSION

Comparing the different substrates, one can notice the difference in wire distribution. On the glass substrate more wires are obtained while also typically being longer in length. Also of note, is the fact that the ones grown on the coating are not in full focus. This is due to the wire being at different distances away from the lens of the microscope, implying that they are vertical with respect to the substrate. From this result, one may conclude that a metallic coating such as the gold/palladium one used here provides a sort of nucleation site for the wires to begin growing in a direction that is not always in contact with the substrate.

The SEM images show a more detailed structural view of the wires. The pointed tips leave a very exciting opportunity as the narrower the tip, the more directional control of light emission should be observed.

FUTURE DIRECTIONS

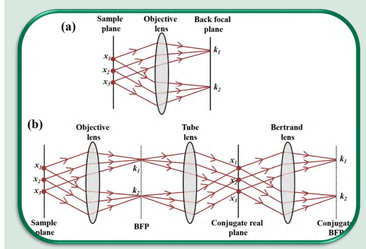


Fig 8. Back focal plane imaging principle

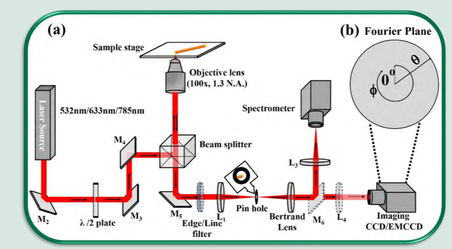


Fig 9. Optical setup schematic

Planned investigations include:

- Light propagation with pulsed laser illumination
- Directional emission as a function of end-face morphology
- Coupling the nanofibers with different plasmonic nanoarchitectures
- Investigation of coupling effect in hybrid nanostructures

ACKNOWLEDGEMENTS

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