Development of Biocompatible Graphene Quantum dots with Near-Infrared Fluorescence

MARANATA DADET, ANTON V. NAUMOV, BONG HAN LEE
DEPARTMENT OF PHYSICS AND ASTRONOMY
OBJECTIVE

• Develop more quantum dots that can emit in the near infrared region
BIOAPPLICATIONS OF QUANTUM DOTS

- Dug carrying agents
- Imaging agents
- Small size
- Fluorescence
- Benign

GRAPHENE QUANTUM DOTS WITH NIR FLUORESCENCE

- Developed more Graphene GQDs
- Used Top-down and Bottom-up approaches

**Bottom-Up Synthesis:**
- Glucose and Liquid Ammonia
- L-Glutamic acid

**Top-Down Synthesis:**
- Reduced Graphene Oxide

Top-Down Synthesis

- The building blocks of a bulk material are separated to form the nanomaterial.
- Involves scission of the larger material with physical or chemical means.

Bottom-Up synthesis

- Atoms assemble and form clusters to make the nanomaterial.

Top down – reduced graphene oxide-based quantum dots (RGQDs)
Optical Properties - RGQDs

Fluorescence spectrum

- 808 nm laser excitation

Absorbance spectra

- 0.01 mg/mL
- 0.009 mg/mL
- 0.008 mg/mL
- 0.007 mg/mL
- 0.006 mg/mL
- 0.005 mg/mL
- 0.004 mg/mL
- 0.003 mg/mL
- 0.002 mg/mL
- 0.001 mg/mL
Bottom-Up
Glucose and NH3OH-Based GQDs

1. Mixture of the precursors with water
2. Microwave synthesis
3. Resulting Solution
Optical Properties - Glucose + GQDs

Fluorescence spectrum

Absorbance spectrum
Sample of L-Glutamic Acid → Melted using oven → Mixture of the melted precursor with water is stirred → Resulting Solution
Optical Properties - L-Glutamic Acid-Based GQDs

Fluorescence spectrum

Absorbance spectrum

- Wavelength (nm)
  - Fluorescence spectrum: 860, 870, 880, 890
  - Absorbance spectrum: 300 to 800 nm

- PL Intensity (counts)
- Absorbance Intensity (a.u.)

808 nm laser excitation
Summary

- While multiple synthetic procedures attempted, 3 types of synthesized GQDs appeared to have beneficial near-infrared fluorescence.
- There are few to none such structures with near-infrared emission developed in the World.

Trials and Errors

- Urea Citric + Acid + Hydrogen peroxide
- Folic Acid
- Aniline

Future applications

- Cell Imaging
- Animal/Human (low depth) imaging
- Optoelectronic devices
- pH-based cancer sensors:

Conclusion
Graphene Quantum Dots that are harmless nanoparticles that can emit light in the infrared region (750-2500nm). Due to those two properties, they are good to be used to detect and deliver drugs to cancerous cells. They can image which part of the body might have tumors and make it easy for doctors to target and remove them. They can also be used to deliver drugs to the body without having to go through chemotherapy. They could be mini doctors. GQDs have the potential to be the reality we have seen from Sci-Fi movies.

Given that there currently are only few kinds GQDs known to emit light in the Near Infrared region, our lab sought to find whether more kinds of GQDs could be made and have found three. This amazing achievement brings us closer to find better ways to detect and cure cancer and save lives. It means that soon, no one will have to lose a loved one due to cancer.
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