# Optimization of the Breakdown of Carbon Nanotubes into GQDs

**Alyssa Dickens**, Anton V. Naumov

Department of Physics and Astronomy, Texas Christian University

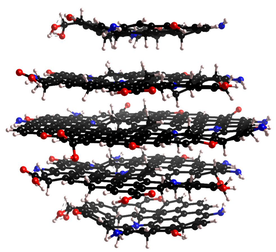
## Abstract

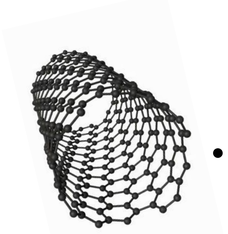
Graphene quantum dots (GQDs) have gained significant attention due to their unique optical properties, biocompatibility, and potential applications in bioimaging, biosensing, and optoelectronics. The breakdown of single-walled carbon nanotubes provides an alternative method of producing GQDs that has the potential to be more efficient than current methods. We will investigate the effectiveness of various methods to break down single-walled carbon nanotubes, including through UV-light irradiation. Solutions of carbon nanotubes with sodium hypochlorite are placed under 254nm UV-light for one and two hours, and fluorescence in the visible spectrum is measured before and after UV-light irradiation to observe the production of GQDs. The use of surfactants in these solutions can affect the resulting fluorescence, so solutions of sodium dodecyl sulfate (SDS) and sodium dodecylbenzene sulfonate (SDBS) are also UV-light irradiated and observed. We will perform transmission electron microscopy (TEM) analysis on the samples to characterize the resulting GQDs and determine their size distribution. The findings from this study will contribute to the broader scientific community by improving an avenue of production for GQDs through conversion of carbon nanotubes into smaller, more functional materials while reducing the toxicity associated with carbon nanotubes.

## Introduction

### Graphene Quantum Dots (GQDs)

- Water soluble
- Nano-sized
- Applications in:
  - Drug delivery
  - Cell imaging
  - Gene targeting

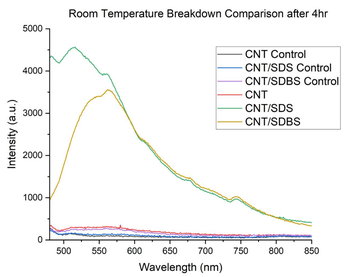


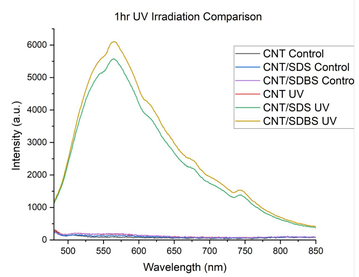


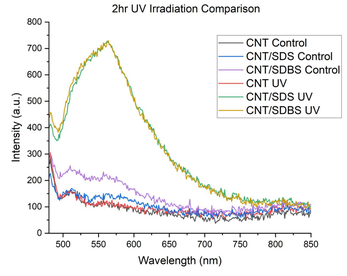
### Carbon Nanotubes into GQDs

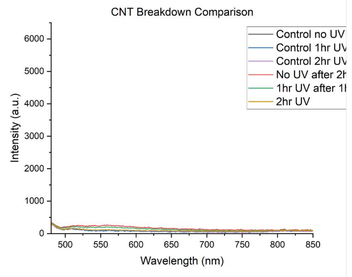
- Bleach and surfactant facilitates breakdown
- UV irradiation accelerates breakdown process

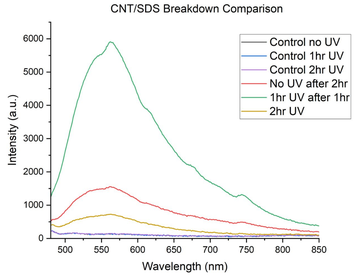
## 565 nm Fluorescence Peak (470 nm Laser)

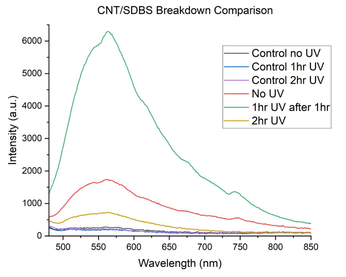


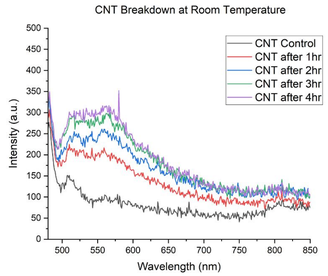



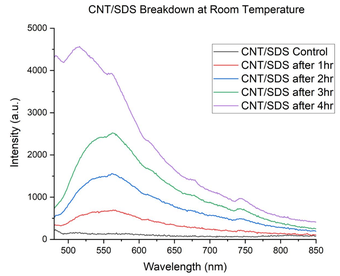



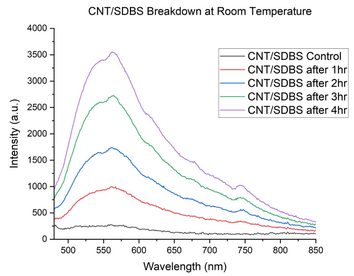



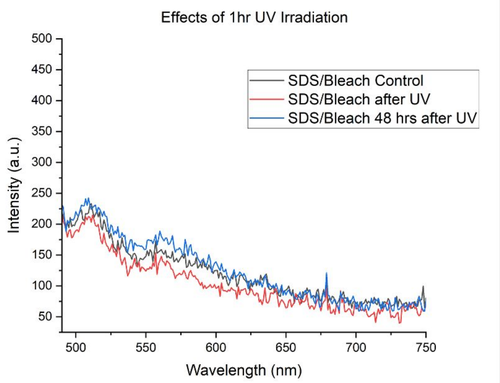



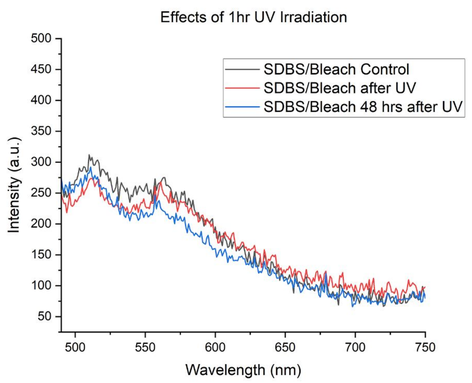



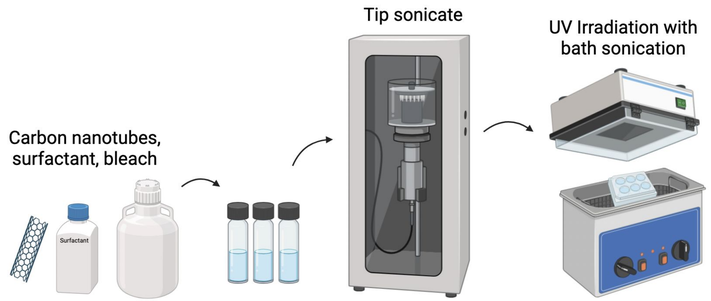




## Bleach & Surfactant




## Methods




- Formulated three solutions containing carbon nanotubes: one with no surfactant, one with added SDS, and one with added SDBS
- Tip sonicated all solutions, then made samples adding sodium hypochlorite
- Placed samples in a well plate and UV irradiated while bath sonicating for one and two hours
- Measured fluorescence before and after UV irradiation

## Conclusion

- UV irradiation at 254 nm accelerates the breakdown of single-walled carbon nanotubes into GQDs
- 1 hour UV is best, while longer exposure (2 hours) causes over-oxidation and reduces fluorescence
- UV irradiation is more time-efficient than non-UV oxidation
- 4 hours without UV produces lower fluorescence than 1 hour with UV
- Fluorescence is due to nanotube breakdown, not bleach–surfactant effects as shown in graphs
- Surfactant is necessary as nanotubes are insoluble in deionized water
- Will perform TEM analysis to confirm GQD formation and size
- Additional experiments at 70 °C to compare thermal breakdown with UV
- Method provides a faster approach to producing GQDs for applications like drug delivery, imaging, and gene targeting

## References

Yang, Mei, et al. "Rapid Room Temperature Degradation of Carbon Nanotubes by Sodium Hypochlorite and UV-Light Irradiation." *Carbon*, 2023, pp. 238–246. https://doi.org/10.1016/j.carbon.2023.03.046