Consideration for **The Randall Harper Award for Outstanding Undergraduate Research in Physics and Astronomy**

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I would like the committee to consider my research at WKU in the optics lab for the Randall Harper Award. This research explores graphene quantum dots (GQDs) as a viable application in photodynamic therapy. Photodynamic therapy (PDT) has been a focus of biomedical research in the treatment of cancers, bacterial infections, and viral infections in that it is relatively non-invasive, exhibits low toxicity, and due to the specificity and selectivity in localized deactivation. Few photosynthesizers have shown ideal properties to be used as in vivo treatment in PDT. Our group proposes a pulsed laser synthesized GQD as a viable photosynthesizing agent due to their low toxicity, good fluorescence properties, time efficient ease of production, and biocompatibility.

This research was initially difficult in using a pulsed laser synthesis method to produce the desired size of GQDs that exhibited the expected fluorescent properties. The size and fluorescence of these GQDs were indicators of their structure, morphology, and functional groups important in understanding how they react as photosynthesizers. Our group worked tirelessly trying the find the laser parameters and experimental conditions that would generate dimensionally satisfying GQDs. I quickly learned how to adjust experimental parameters using optical equipment and became familiar with the operation of our Q-switched Nd:YAG nanosecond pulsed laser. I was given the opportunity to run experiments in synthesizing our GQDs given different experimental parameters. In this phase of the research I also learned to operate the Scanning Electron Microscope and the Transmission Electron Microscope at WKU to characterize the shape and size of our GQDs. We were able to produce GQDs at less than 10 nm in size with a particle distribution centered about 2 -3 nm. A line profile analysis of the interlayer spacing of the diffraction fringe was also used to characterize our GQDs. Further characterization included UV-VIS spectrophotometer and spectrofluorometer to understand the absorbance and fluorescence of our GQDs, an important aspect of their use as photodynamic agents.

After obtaining the desired multilayer particle size, we began measuring the singlet oxygen generation of our GQDs using anthracene-9, 10-dipropionic acid, disodium salt (ADPA). Singlet oxygen is the reactive oxygen species responsible for localized deactivation of bacteria in photodynamic therapy. Measuring the singlet oxygen generation quantifies the efficiency of our GQDs are as photosynthesizer. This included irradiation of a GQD/ADPA solution by 660 nm LED and subsequent measurement of the intensity of the absorption peak to determine efficacy of singlet oxygen generation. The singlet oxygen production of our GQDs were then compared to that of Methylene Blue (MB), a known photodynamic therapy agent. We then began testing efficacy of a GQD and GQD/MB bioconjugate in deactivation of Escherichia coli (E. coli). A standard plate count method was used to measure bacteria colonies before and after treatment for a control sample, a GQD treated sample, and a GQD/MB treated sample. The results showed that a GQD/MB treatment was most effective in deactivating E. coli. Further developments in our research have used a sulfur-doped GQD/MB treatment to increase the efficacy in bacteria deactivation.

For the past two years, I have been provided a fantastic opportunity with my research group, I’ve not only learned new areas of applied physics but also communication skills, team building, public speaking, data analysis, and time management. Furthermore, my technical writing has improved, I have fostered invaluable relationships with my professors, and am able to find new ways to approach difficult problems. My research on graphene quantum dots in photodynamic therapy is cutting edge, an excellent candidate for the Randall Harper Award.