The Randall Harper Award

for Outstanding Research in Physics and Astronomy

Award Application Form

Deadline February 16

Name of Applicant: Lauren Cooper

Applicant's Class: ○ Junior ◉ Senior

Applicant's Major: Mechanical Engineering

Overall GPA: 3.85

Applicant's Local Address: 1504 Park St., Apt. #B15, Bowling Green, KY, 42101

Applicant's Local Phone: 502-644-2597

Name and Addresses of Applicant's Parents or Guardians:

Jean Cooper
3903 Manner Dale Dr.
Louisville, KY, 40220

Recipient's Hometown Newspaper: Courier Journal

Listing of Research Publications and Presentations:

-Lauren Cooper, Khomidkhodza Kholikov, Ilhom Saidjafarzoda, and Ali Oguz Er, "The Production of Aluminum Nanoparticles via Pulsed Laser Ablation for Application in Bacterial Deactivation", SESAPS 85th Annual Meeting, Knoxville, TN (November 8-10, 2018) ~Poster Presentation~

-Lauren Cooper, Khomidkhodza Kholikov, Ilhom Saidjafarzoda, and Ali Oguz Er, "The Use of Pulsed Laser Ablation to Produce Aluminum Nanoparticles for Applications in Bacterial Deactivation", Kentucky Academy of Science 2018 Conference, Bowling Green, KY (November 2-3, 2018) ~Oral Presentation~

-Lauren Cooper, Khomidkhodza Kholikov, Ilhom Saidjafarzoda, and Ali Oguz Er, "Improved Antimicrobial Activity of Graphene Quantum Dots for Application in Photodynamic Therapy", Kentucky Round Table 2018 Meeting, Bowling Green, KY (October 6, 2018) ~Poster Presentation~

-Lauren Cooper, Adam Hoffman, Alexey Boubnov, and Simon Bare, "Simulation of Metal and Metal Oxide Nanoparticles to Aide Shape Characterization by EXAFS", Summer Undergraduate Laboratory Internships (SULI) Symposium, Stanford Linear Accelerator Center National Laboratory, Menlo Park, CA (August 17, 2018) ~Oral Presentation~

-Lauren Cooper, Khomidkhodza Kholikov, Ilhom Saidjafarzoda, Zachary Thomas, Skyler Smith, and Ali Oguz Er, "The Effects of Photo-Activated Graphene Quantum Dots on Bacterial Deactivation", 48th Annual WKU Student Research Conference, Bowling Green, KY (March 24, 2018) ~Poster Presentation~

-Lauren Cooper, Khomidkhodza Kholikov, Ilhom Saidjafarzoda, Zachary Thomas, Skyler Smith, and Ali Oguz Er, "The Effects of Photo-Activated Graphene Quantum Dots on Bacterial Deactivation", Posters

Attach one (and only one) page providing a description of the research for which you wish to be judged. The quality of the described research will be based on originality, creativity, difficulty, and significance.

Application for the Randall Harper Award

Lauren Cooper

I would like to be considered for the Randall Harper award for my research conducted in the Optics Laboratory at Western Kentucky University under the guidance of advisor Dr. Ali Er. My research was conducted as part of a larger work of the Optics Laboratory into alternative methods for treatment in the face of increasing levels of antibiotic resistance. Antibiotic resistance is one of the greatest issues in modern healthcare, and much research is being funneled into assisting in overcoming this issue[1]. As such, many novel methods of care have been proposed in recent years, one of the most promising being photodynamic therapy. Photodynamic therapy (PDT) works by utilizing materials referred to as photosensitizing agents that are injected into a certain region of interest (wounds, tumors, etc) within the body. Once the photosensitizing agents are optically excited by a certain wavelength of light, the agents will begin releasing harmful forms of oxygen such as reactive oxygen species that deactivates surrounding malignant cells. PDT has already been applied to the treatment of some forms of disease, with relatively high success[2].

In the work conducted with the Optics lab at Western Kentucky University, I have been collaborating with other group members to fabricate new forms of photosensitizing agents. Specifically, our group is combining graphene quantum dots (GQDs) with methylene blue (MB), a well-known antibacterial agent, to increase the efficacy of the MB in PDT in deactivating bacterial cultures. To aid in this project, I utilize our Q-switched Nd:YAG laser to create the graphene particles from benzene and nickel oxide. Once the particles have been fabricated, I then process the particles using centrifugation, filtration of the benzene, recombination with water, and then utilization of a syringe filter to ensure only particles smaller than ~5 nm are present in the final sample.

Once the particle sample is in the desired form, I characterize the optical properties of the GQDs using photoluminescence, UV-Vis, and Fourier Transform Infrared spectroscopy (FTIR), and I image the particles with Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). After the particles have been properly analyzed, I test the photobleaching potential of the GQDs by testing their rate of deactivation of 9,10-Anthracenediyl-bis(methylene)dimalonic Acid, or ABMDMA, which is a reagent used in biomedical applications to test singlet oxygen generation. Depending on the results of these tests, I then aid in the next phase of characterization: level of deactivation of bacterial cultures.

Although I am not personally able to contribute to the testing of GQDs in bacteria due to my undergraduate status, I help to fabricate the agar plates that are used to test the GQDs and bacteria. Then, after testing with bacteria, I aid in interpreting results to ascertain whether or not the tests produced favorable outcomes, and what may be changed if not. Thus far in our experiments, we have been able to prove that the combination of GQDs and MB is more efficient in eliminating bacterial cultures than MB alone. These results suggest that a GQD:MB solution poses an effective alternative to more standard treatment methods.

Resources

[1] Woolhouse, Mark, et al. "Global Disease Burden Due to Antibiotic Resistance - State of the Evidence." *Journal of Global Health*, Edinburgh University Global Health Society, June 2016, www.ncbi.nlm.nih.gov/pmc/articles/PMC4920009/.

[2] Triesscheijn, M., et al. "Photodynamic Therapy in Oncology." *The Oncologist*, vol. 11, no. 9, 2006, pp. 1034–1044., doi:10.1634/theoncologist.11-9-1034.

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