STUDENT AWARDS FOR RESEARCH AND CREATIVITY (SARC) APPLICATION

Application for Summer 2022 Award DUE BY 5pm, Friday, March 11, 2022

Application Instructions:

1. Identify a faculty sponsor of your research or creative project who will write a letter of recommendation in support of the application. Letter of Recommendation must be submitted by 5pm, Friday, March 11, 2022.
2. Submit application and supporting documentation online at: https://www.csuchico.edu/ued/student-awards/index.shtml

****IMPORTANT****

Applications or references submitted after Friday, 5:00pm, on the day of the deadline will not be considered.

Full Name: Preston Scott Lawson

Cumulative GPA:

CSU ID#

Major(s): Chemistry

Expected Graduation Date:

Mailing Address:

(City) (State) (Zip Code)

Local Phone:

Research/Creative Project Title: Nanomaterials for Greener Solar Energy

Award Requested (choose one): Summer Award, Undergraduate

Amount requested: $2500

- Spring Award, Undergraduate ($850 maximum award)
- Spring Award, Graduate ($1700 maximum award)
- Summer Award, Undergraduate ($2500 maximum award)
- Summer Award, Graduate ($5000 maximum award)
- Fall Award, Undergraduate ($850 maximum award)
- Fall Award, Graduate ($1700 maximum award)

Will applicant be funded by any other source during the period of the project? (If yes, details and amounts should be specified in the narrative description.)

Has applicant received a SARC award before? (If yes, faculty sponsor must request and receive special permission prior to the sub[redacted] application)

Has applicant applied for a SARC award before?

Chico State email address: [redacted]

Faculty Sponsor name: [redacted]

Faculty Sponsor email address: [redacted]

Applicant Signature [redacted] **Date:** 3-11-2022

Nanomaterials for Greener Solar Energy

Preston Lawson

A. *Explanation of the work*

Gas prices have been increasing for months, driven by a fundamental mismatch between high global demand and a lower supply of oil. Recently, due to the U.S. banning imports of crude oil from Russia, California's average gas prices have soared to $5.34 per gallon. Thus, since political and economic forces destabilize oil prices globally, we must invest in more renewable energy technologies domestically. On top of recent events, the long-term devastating repercussions of burning fossil fuels have already begun, necessitating carbon-neutral alternatives like solar energy. Though solar energy conversion technologies have made amazing strides in performance over the past four decades, the majority of commercially available solar cell technologies contain toxic heavy metals, primarily lead. All solar panels will degrade over their lifetime, leading to the potential leaching of toxic metals into the environment. Eventually, these panels must be recycled or disposed of and any toxic contents must be removed properly.

Having minimal hands-on lab experience due to the pandemic and being curious about renewable energy research, I joined Dr. So's lab this semester to develop my skills and prepare for my project for the summer and fall of 2022. My research goal is to synthesize and characterize lead-free perovskite solar cells. Perovskites are a highly customizable family of hybrid organic-inorganic nanomaterials, as different halides and metallic cations can be added or removed to change the light-absorption properties, allowing us to optimize efficiency. The most likely candidate for replacing lead in perovskites is tin. Like lead, tin is in the same column of the periodic table and can coordinate in such a way to form a viable perovskite structure for solar cells. However, unlike lead, tin is non-toxic.

B. *Student contribution to project design and execution*

To test the effects of different metal cations in the perovskites, I will synthesize, fabricate, and evaluate the perovskites in solar cells. In the first step, I will synthesize the tin and lead-based perovskite nanomaterials using published procedures. Dr. So has all the reagents, glassware, and safety equipment necessary to perform this step in her lab at CSU Chico. Then I will assemble solar cells using the tin and lead-based perovskites. Since each solar cell is assembled of several layers applied one at a time, an even layer distribution and strong adhesion is required between layers. The contact angle goniometer proposed in my SARC budget (Table 1) enables diagnostic measurements of how liquids interact with solid surfaces. It measures the angle that the edge of a liquid droplet makes when in contact with a surface, and the angle measured indicates whether the surface is hydrophobic or hydrophilic. This data will help us troubleshoot undesirable morphology and help improve the quality of the final product, ensuring the layers adhere well to the solar cell substrate. The morphology is the microscopic shape or surface texture of the material being made. Thirdly, I will collect data to compare the two types of perovskites. The difference between the two is the metal cation, which I hypothesize will affect its light absorption and solar cell performance. In the Department of Chemistry and Biochemistry at CSU Chico, I will use X-ray diffraction (XRD) and energy-dispersive x-ray spectroscopy (EDXS) to confirm the perovskite structure and the presence of the metal cations, respectively. I will use atomic force microscopy (AFM) and scanning electron microscopy (SEM) to elucidate the morphology of the solar cell's active layer. Then, using a solar simulator, I will test the current and voltage characteristics to determine the overall device efficiencies of the perovskite solar cells.

C. Expected benefits of the award to the student

As outlined above, I will work individually on this research project, which is supervised by Dr. So. Once I have preliminary results, I plan to present them at the American Chemical Society (ACS) National Meeting in March 2023 and the CSU Chico College of Natural Sciences Poster Session in May 2023. Through this experiment, I will gain my first experience in research, as well as knowledge of different applications of perovskites. I will also gain new lab skills, become more proficient with instrumentation, solve challenging problems, analyze data, and importantly, scientific presentation skills.

D. Broader impact of the work

If successful, we expect tin perovskites to be "greener" when incorporated into solar panels. They would not leach toxic heavy metal ions and would be environmentally safer. The sooner we can eliminate the burning of fossil fuels, the better chance we have to combat the climate crisis and work towards energy independence.

E. Itemized and detailed budget

SARC Budget	
1. Supplies/Materials	
Ossila Contact Angle Goniometer with software	2,100
Supplies/Materials Category Subtotal:	2,100
2. Stipends	
1 student summer salary: $360 (24h @ $15/hr) + $40 (10.5% fringe) = $400*	400
*Dr. So/Department of Chemistry & Biochemistry will match 90% of my summer stipend.	
Travel Category Subtotal:	400
TOTAL AMOUNT REQUESTED (Maximum Request = $2500):	$2,500

Table 1. Itemized budget of SARC proposal.