UNIVERSITY OF LOUISIANA AT LAFAYETTE

STEP Committee

Technology Fee Application

Chemical Reactions with Light: UV Lamps for Photochemical Experiments in Organic Chemistry Labs

Title

Thomas Junk and Ryan L. Simon

Name of Submitter
(Faculty or Staff Only)

UL Department of Chemistry

Organization

Title: Professor/Head (Junk) , Instructor (Simon) Date: 7/12/17
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ABSTRACT (250 words or less):
Photochemical reactions, those initiated by ultraviolet (UV) light, comprise and important class of chemical reactions, notably in organic and polymer chemistry. In addition, UV light is commonly used to visualize fluorescent labels and indicators. Currently, such photochemical reactions can only be covered in theory because the corresponding UV light sources are missing in our Department of Chemistry. Funding is requested to purchase four (4) high power UV lamps. This will enable us to carry out student experiments with ultraviolet light. More specifically, the lamps are intended in support of an existing experiment carried out in CHEM 233, our first organic laboratory, and a new experiment planned for CHEM 234, our second organic chemistry laboratory. At 24 students per section, four lamps will be needed. We anticipate that approx. 400 students per year will be using the requested UV lamps. They are rugged, require no regular maintenance, are easy to operate and represent a relatively minor investment with a significant benefit to our program.

3a. Purpose of grant and impact to student body as a whole

Chemical reactions induced by light are ubiquitous, ranging from the common sunburn to the use of light sensitive coatings and light cured dental fillings. Consequently, photochemistry finds extensive use in organic chemistry, polymer chemistry, and materials sciences. Light is also used as an analytical tool, notably for the detection of fluorescence indicators in chromatography. In biochemistry labs, intense light is valuable for sterilization purposes. These applications, however, require the proper type of light, namely high intensity ultraviolet (UV) light. Visible light is rarely suited to induce chemical reactions. While our chemistry lectures, notably organic chemistry CHEM 232, address photochemical reactions and their utility, our laboratories currently cannot provide any matching experiments. I fact, the implementation of photochemical experiments is neither difficult nor expensive, all that is needed is the one-time expense to purchase suitable high powered UV lamps.

<u>Current status:</u> Other than several aging, low intensity hand held “black lights”, there currently are no UV sources available in our department in support of teaching. The only comparable UV lamp in our department failed years ago. Consequently, no hands-on examples of photochemical reactions are provided or can be implemented in our teaching laboratories.

<u>Purpose and Objectives:</u> We propose the purchase of four high powered UV lamps. These are portable units which can be relocated easily, but will be used mostly in Montgomery Hall 232 in support of our CHEM 233 and CHEM 234 labs. They will primarily support and existing thin layer chromatography (TLC) experiment, during which they will help students inspect their chromatographic plates to identify their analytes, and for the introduction of one photochemical synthesis. Several procedures well suited for our needs have been published, one of which will be selected and included into the CHEM 234 curriculum:

1. Preparation of Benzopinacol in: Experimental Methods in Organic Chemistry, (3/e), Moore/Dalrymple/Rodig, Holt, Rinehart & Winston, Inc., 1982.

2. A Novel Photochemistry Experiment Using a Diels-Alder Reaction. Nash, E. G. Journal of Chemical Education 1974, 51 (9), p 619.

3. Photodimerization of Anthracene, Gary W. Breton and Xoua Vang. Journal of Chemical Education 1998, 75 (1), p 81

The chosen experiment will serve to demonstrate the utility of ultraviolet light sources in initiating chemical reactions. It will be carried out by students safely and without additional specialized resources. Each lab enrolls 24 students and one UV light will accommodate up to six students, hence four UV lights are budgeted. While the use of natural sun light is feasible in some cases in southern regions with reliably sunny weather, we will have to rely on artificial UV light sources for photochemical reactions.

In addition, the proposed UV light sources will be made available for student research projects (Undergraduate Research I and II, CHEM 362 and CHEM 462) when not in use. With the recent hire of a polymer chemist, we are currently strengthening our polymer chemistry curriculum. UV lights are used extensively to initiate polymerization and for the photocuring of polymers.

Impact: Our chemistry program has been undergoing rapid growth. Enrollments in our classes have increased from 3,429 students in 2009 to 5,103 students in 2016, or a 46% increase in seven years. The proposed UV lights are expected to mostly benefit students enrolled in organic lab courses (currently approx. 380 enrollments/year), polymer chemistry (currently in preparation), as well as those conducting research. Overall, we anticipate that approximately 400 students per year will use the requested UV lamps. In addition, a classroom demonstration showing the photobromination of a hydrocarbon is planned for Organic Chemistry II lecture (CHEM 232), as previously implemented by the author at a former place of employment. Due to the rapid growth of our program, the number of students enrolled in pertinent classes is expected to further increase over the next years. Our graduates are expected to have hands-on experience in common laboratory techniques. The proposed acquisition will ensure that they meet this expectation.

3b. Projected lifetime of enhancement

The requested lights do not have a set expiration date. While the useful life span of the requested lamps depends on the extent of their use and can only be estimated, a lifetime of 15+ years can be expected for the body of each lamp. We estimate that their light bulbs will have to be replaced every 3-5 years, a rather modest expense that will be covered by our department.

3c. Person(s) responsible for:

i. Implementation

T. Junk will procure the budgeted four UV lamps. These are “ready to use” by design. They will be located at the site of our organic chemistry laboratories, but are portable and accessible for demonstration experiments and other teaching needs. Simon and Junk will collaborate to introduce the lamps into teaching.

ii. Installation

No installation is necessary, the lamps are ready for operation when powered up.

iii. Maintenance

No regular maintenance is anticipated. The light bulbs of UV lights will eventually fail after extensive use. At this time, they will be replaced with another matching UV light bulb.

iv. Operation

UV lights will be operated by students, under the supervision of faculty to preclude unsafe handling/operation. Just like natural sunlight, UV lamps can cause “sun burn” or eye damage when improperly used. This can be easily avoided by assuring that students do not remain in the vicinity of operating UV lights for extensive periods of time.

v. Training (with qualifications)

Faculty who teach organic chemistry, polymer chemistry or supervise student research are already familiar with ultraviolet light sources and their applications, which are available at virtually all institutions with graduate programs. Drs. Simon, Junk and Gallo will cover student training for organic chemistry labs. All other chemistry faculty will have access to the proposed UV lights and will obtain departmental support or instructions if needed.

Budget Proposal

1.	**Equipment**	**$**	**2,100.00**
2.	**Software**	**$**	**0.00**
3.	**Supplies**	**$**	**0.00**
4.	**Maintenance**	**$**	**0.00**
5.	**Personnel**	**$**	**0.00**
6.	**Other**	**$**	**0.00**
TOTAL:		**$**	**2,100.00**

d. Budget Narrative:
The equipment request covers four (4) Fisher Scientific Blak Ray B-100A High Intensity UV Lamps, at $525 each.

Previous funded STEP projects

T. Junk previously authored the following funded STEP proposals:

1. Smart Classrooms in Chemistry, T. Junk and A. Gallo, $30,000, awarded in 2012.
2. Laptop Computers for Chemistry Lectures, T. Junk, $3,285, awarded in 2013.
3. Raman Spectroscopy in Chemistry Labs, T. Junk, $10,655, awarded in 2015.
4. Purchase of an Attenuated Total Reflectance (ATR) Tool for Chemistry to Conduct Infrared Spectroscopy on Solids, $5,602.50, awarded in 2016.
5. ChemDraw chemical structure drawing software for student use and training, T. Junk, $4,460, awarded in 2017.

R. Simon previously authored the following funded STEP proposals:

1. Organic Chemistry Laboratory Equipment Grant, R. Simon and A. Gallo, $3666.50, awarded in 2016.
2. Demonstration Equipment Grant, R. Simon, $501.64, awarded in 2017.
3. Maker Lab for Montgomery Hall, R. Simon and Y. Wang, $3649.79, awarded in 2017.

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