



*In Conjunction with the American Chemical Society  
Student Affiliates at the University of Pittsburgh*



**Volume 25, Issue 6**

**March 4, 2016**



**It's Back!**  
REGISTRATION



## Fall Term (2171) Registration

**March 18** Deadline for applying for August 2016 graduation (140 Thackeray Hall).

**March 28** Fall Term (2171) Registration begins based on credits earned.

→ *You will be notified of your registration time on your my.pitt.edu page.*

Advisees who already have a permanent advisor should make their registration appointments with that advisor on or after **March 14** for Fall Term (2171).

Advisees who were asked to select their permanent advisors (via a letter sent Feb. 1) should schedule their Fall term registration appointment with their new advisor after **March 14**.

New advisees who have declared chemistry as his or her major within A&S should make an appointment with Dr. George Bandik, Dr. Ericka Huston, or Dr. Michelle Ward after **March 14** for Fall Term (2171) in 107 CHVRN.

### Departmental Honors? Here's How...

Students who wish to graduate with Chemistry Department honors must satisfy four departmental requirements. Students must have:

- (a) an overall QPA of 3.00 or better
- (b) a chemistry QPA of 3.25 or better
- (c) have completed at least 2 credits of  
Chem 1710-Undergraduate Research
- (d) completed Chem 1711-Undergraduate Research Writing.

**Good luck as you strive towards academic excellence!**

## 2015-2016 ACS-SA Officers and Staff

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Visit us at <http://www.chem.pitt.edu/acs-sa/>

CHEM MAJOR NEWS

# ACS-SA Schedule for the Spring Term



## MARCH

- 04 Meet Our New Faculty
- 11 SPRING BREAK-Have Fun!
- 18 Preparing for Saturday Science
- 25 NO MEETING

## APRIL

- 01 Spring Birthday Bash
- 08 Officer Nominations
- 15 Officer Elections
- 22 SENIOR FAREWELL

## CAMPAIGN! VOTE! WIN!

Have you ever wanted to lead a nationally acknowledged award winning student group? If you aspire to such things why not consider running for an office with our ACS-SA group. We boast some 100+ members and have been recognized for the past 24 years by the national ACS for outstanding programing.

Nominations for our 4 elected positions: president, vice president, treasurer and secretary will be held on April 08 at our weekly meeting, 12:00 Noon in 154 CHVRN, and elections will be held on April 15th.

Stephanie Liu and Nuria Marques have agreed to be Co-Editor's of next year's Chem Major News, Pat Asinger and Alex Richter have agreed to serve as Outreach Coordinators. Thanks to these great folks!

Get involved and help a great group maintain its reputation! We need you!



## SMALL GRANTS FOR YOUR PROJECTS.

The A&S Office of Undergraduate Research, Scholarship and Creative Activity is offering small grants for your individual research or teaching projects, presentations or creative endeavors. These grants of up to \$500 are available for the following kinds of expenses:

- research/project supplies
- travel if you are going to present a paper at a conference or perform in an artistic endeavor.

To apply for a research/creative endeavors or travel/presentation grant, you must:

1. Find a faculty sponsor for your project.
2. Complete the application form. Include a detailed description of your project or travel plans and budget.
3. Return the signed form to the Office of Undergraduate Research, Scholarship and Creative Activity, 209 THACK.



# Try Something Different...

Need something new and exciting in your life? Tired of the same old thing? How about some new (or not always offered) courses for the Fall term? Three elective courses being offered this fall may bring that zing back into your life! May we suggest:

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## **Chemistry 1310-"Organic Synthesis"**

This course fills in the gap between the basic undergraduate organic chemistry courses and the graduate school level. Organic synthesis is the scientific backbone of organic chemistry, and though often neglected in the undergraduate curriculum due to their complexity, synthetic tactics and strategy are among the most creative and useful expressions of scientific excellence.

The course will use modern organic synthesis as a framework to learn about advanced organic structures, organic reactions and organic reaction mechanisms. Outside class, you will learn how to critically read the original literature through periodic assignments.

The course is ideal for anyone who plans to look for a job or continue for an advanced degree in organic chemistry or any area associated with organic chemistry. A reasonable (B or better) knowledge of introductory organic chemistry is expected, but we will open each new topic with a refresher.

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## **CHEM 1620 – "Atoms, Molecules, and Materials – Introduction to Nanomaterials"**

This will be a course designed to increase students' knowledge and understanding of emerging field of nanotechnology. Nanotechnology deals with materials in nanometer scales, typically one to 100 nanometers. One nanometer is one billionth of a meter; approximately the length of five silicon atoms placed side-by-side or the width of a single strand of DNA. On nanometer scale, materials may possess new physical properties or exhibit new physical phenomena. For example, band gaps of semiconductors can be effectively tuned by adjusting their nano-dimensions. For nanomaterials, number of surface atoms becomes a significant fraction of the total number of atoms and the surface energy starts to dominate. This changes thermal stability and catalytic properties of many materials as we know them.

During the course, the students will gain a sound appreciation of different techniques and instruments involved in the preparation and characterization of nanomaterials. Current and future applications of nanomaterials in medicine, defense, energy production, and computation will be also discussed.

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## **Chemistry 1810-"Chemical Biology"**

Revolutionary transformations in chemistry and biology have led to a merging at the boundary of these disciplines where contributions from both fields impact our molecular and quantitative understanding of biology. Rapid growth in this area has been driven in part by researchers applying synthesis, quantitative analysis, and theoretical reasoning to the study complex cellular processes. This course focuses on enzyme mechanisms in biological pathways, kinetics and thermodynamics, and chemical tools to probe and screen components of the cell. Other topics that will be discussed include DNA/RNA processing, macromolecular interactions, chemical signaling, posttranslational modifications, chemical syntheses of biomolecules, and the development of assays for high throughput drug screening.

This course is ideal for students interested in the interface between biology and chemistry. You will first learn to recognize sufficient unresolved problems in biology that will benefit from a whole system chemical and molecular approach to analysis. Chemical tools from all areas of chemistry (analytical, inorganic, organic, and physical) will be employed to characterize and elucidate biological processes. This course will be taught from both a "top down" and "bottom up" approach to characterizing cellular responses. Individual interactions and mechanisms of biological pathways ("bottom up") will be discussed in addition to and in context with the analysis of a global cellular response ("top down") to chemical agents such as drugs, inhibitors, or chemical probes.

Chem 1810 fulfills one of the two elective biological courses for the chemistry bioscience option. Prerequisites include both Biosci 160 and Chem 320. Students can only receive credit for one of the following courses: Chem 1810, Biosci1000, or Biosci 1810.

**So as you can see, there is something for every chemical taste available to you this Fall!!**



# Green Chemistry

by: Viktor Polites, *Green Chemistry Contributor*



## Novel Methods for CO<sub>2</sub> Capture and Simultaneous Conversion to Solvents

To lay the tools for creating a more sustainable energy economy, research generally focuses on developing alternative sources of energy to lower carbon emissions. But an important piece of the transition is likely to come from carbon-capture technologies that reduce the impact of CO<sub>2</sub> emissions from burning fossil fuels. Currently, the popular method of carbon capture is to use chemical sorbents. The captured CO<sub>2</sub> is then stored deep underground in geological “pockets,” many of which are former natural gas reserves. However, the cost and energy penalty that comes with transporting the CO<sub>2</sub> gas, along with the risk of the gas leaking back into the atmosphere have hindered its widespread implementation.

One alternative potential method is to use captured CO<sub>2</sub> to synthesize value-added chemicals, essentially recycling the carbon. There are several reasons why this method is difficult to implement. Firstly, with the exception of urea, 1-carbon building blocks are not in high demand by the chemical industry. Secondly, the majority of reactions to convert CO<sub>2</sub> to more useful products requires transporting pure, compressed CO<sub>2</sub> from the flue stream to a separate, sometimes offsite facility. Additionally, since carbon in CO<sub>2</sub> is in its highest possible oxidation state, its reduction to useful compounds requires harsh conditions such as high reaction temperatures and/or high-energy reductants such as H<sub>2</sub>.

Recently, Barthel<sup>1</sup> and co-workers reported a novel strategy to synthesize cyclic carbonates

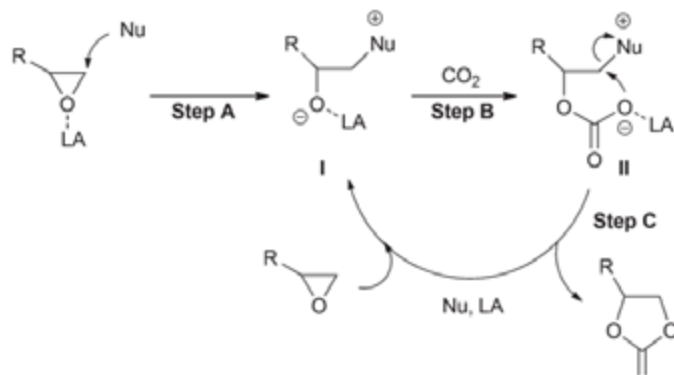


Figure 1. The general mechanism behind the cycloaddition. The catalytic nucleophile attacks the epoxide to yield I (Step A). CO<sub>2</sub> insertion between the O and Lewis-acid catalyst follows (Step B) to yield II. Nucleophilic ring closure by the carbonate regenerates the nucleophile and Lewis-acid.

through a cycloaddition of CO<sub>2</sub> to epoxides (Fig 1). Cyclic carbonates are industrial useful as polar, aprotic solvents with a high dipole moment. Optimization studies using pure CO<sub>2</sub> showed that the reactions proceeded most favorably in terms of CO<sub>2</sub> consumption when the transition metal halides YCl<sub>3</sub>, ScCl<sub>3</sub> and ZrCl<sub>4</sub> were employed as Lewis Acid catalysts, and when tetrabutylammonium bromide (TBAB) was employed as a nucleophilic co-catalyst. Furthermore, the systems worked remarkably well with flue gas as the source of carbon dioxide. Catalyst poisoning by O<sub>2</sub> and NO<sub>x</sub> was not observed. The CO<sub>2</sub> conversion rates reached 90%, which are comparable to rates of carbon

capture by chemical sorbents.

Barthel and co-workers' protocol is not without its drawbacks, though. Epoxides are derived from petroleum, so the process is not entirely carbon-neutral. Still, the method has the potential to be a cost-efficient method to lower the effects of climate change by removing CO<sub>2</sub> from the atmosphere in a cost-efficient manner.

1. Barthel, A.; Saih, Y.; Gimenez, M.; Pelletier, J. D. A.; Kühn, F. E.; D'Elia, V.; Basset, J.-M., *Green Chemistry* **2016**, *Advance Article*.



# Jammin With Chemistry

by: *Nuria Marquez-Newsletter Co-Editor*

Yo bro, you wanna jam?

No, not with instruments. This has nothing to do with music.

This is about that sweet, fruity spread that makes our morning biscuits that much better.

If you've ever tried making your own jam, then you know how tricky it can be. It's not just about following a recipe, but it's about knowing how the jam comes together and having a sixth sense about the science. The chemistry behind making jam boils down to three key components: pectin, sugar and carboxylic acids.

Pectins are long chains of sugar molecules, which are found naturally in plant cell walls. In fruits, these are found specifically in peels and cores. When jam sets, pectin is what makes the jam have the consistency it does. As the fruit boils, the pectins are released; with the right amount of sugar and acidity, the pectin chains will bind together and create that spreadable, jelly consistency. This happens at the 'setting point' of jam, which is around  $104^{\circ}\text{C}$ , or you know,  $377\text{ K}$ . If you're using a fruit with low levels of pectin, like strawberries and raspberries, you'll have to add in apples or blackcurrants, which are higher pectin fruits, or use commercial pectin, which comes from the inner peel of citrus fruits.

We wouldn't love jam nearly as much if it wasn't for its sweet, fruity flavor. So obviously, this is where we talk about the sugars in jam. Many jam recipes recommend the use of a 1:1 ratio of fruit to sugar in jam-making. As well as sweetening the jam, the sugar also helps the pectin set – it enhances the pectin's gel-forming capability by drawing water to itself. Additionally, sugar imparts a preservative effect (which is also why they're called preservatives, duh). By binding water molecules to itself, it reduces the amount of water available in the jam, to the point at which it is too low for microbial growth. The final sugar content of jam should be between 65-69%.

Left to their own devices, the long branches on the pectin chain won't bond with anything around it. They mainly attract water molecules, they have a slight negative charge, and they're very busy. Leave them alone. The added sugar helps with this since it binds to the water molecules and lets pectin do its thing. But leave it to carboxylic acids to fix that pesky negative charge problem.

The COOH groups in the jam are usually ionized, and the negative charges on the molecules this ionization causes can lead to repulsion, and prevent the pectin chains from being able to form the gel network. The pH of the jam needs to be at around 2.8-3.3 in order to properly set. At these more acidic pHs, the COOH groups aren't ionized, so the repulsion between molecules isn't as strong.

Acids are found naturally in fruits, the most prominent is citric acid, but let's not ignore malic and tartaric acid. Some of the acid needed will come straight from the fruit, but believe me, it won't be enough to get that acidic pH. You'll have to add some, most often in the form of lemon juice, which contains citric acid.



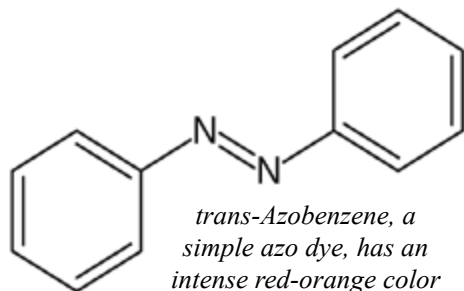
So grab your fruit and your mason jar and get to jammin'!



# LIVE AND LET DIE

By: Dan Willis, *Co-Editor*

Whether you remember it or not, about a millionth of a trillionth of your Organic Chemistry curriculum was devoted to things called ‘azo dyes.’ Ring any bells?



That’s fine, I don’t think anyone expects you to permanently remember a million trillion things. It’s not like azo dyes were even that fascinating to begin with. Azo dyes are a subset of azo compounds—defined by their central N=N double bond—which absorb strongly in the visible region, usually because the substituents on each of these two nitrogen atoms exhibit extensive pi-electron delocalization. Subtly tweaking the identities of these pi-conjugated groups can ‘tune’ the absorption spectrum of the compound, and a seemingly infinite array of strong, safe dyes can be produced as crystalline flakes at room temperature.

That’s pretty cool. But up against experimental cancer drugs with ten-member rings and colloidal solutions of nanoscale gold spheres—things that are patently cool and also *save lives*—azo dyes can seem humble by comparison. Especially knowing that they were first theorized in 1863, and that the first commercially available azo dye was a homely shade called Bismarck Brown, it’s easy to see how they get lost in the blur of OChem II. Azo dyes just aren’t sexy. But here are a few fascinating facts and applications that might make you reconsider.

Azo dyes are commonly used in the manufacture of textiles and clothing. But some potentially harmful nitrogen compounds can result from the breakdown of these dyes if the fabric is not dyed properly. Many fabrics treated with azo dyes have to meet legal limits for aromatic amines that have been linked to the formation of cancer cells. Levi’s alone lists over 100 azo dyes with names like “Basic Red 111” and

“Direct Blue 192” which can decompose into potentially dangerous amines. But oxidative cleavage of the azo nitrogen-nitrogen bond is the best way to deactivate these dyes and achieve ‘stonewashed’ or ‘acid wash’ looks. Sandblasting or immersion in chlorine solution are still the most common treatments, but Levi’s in particular has found an inventive solution for safely deactivating azo dyes: by blasting them with high-pressure ozone!

Here’s a less conventional application. Did you know that most consumer-grade writeable CDs and DVDs use azo dyes? As opposed to the tiny ‘bumps’ on commercially produced media, discs that are burned at home rely on the thin layer of azo dye that is plated on the bottom side of the disc during manufacturing. When the disc is burned, a laser tuned to that dye’s maximum absorbance wavelength excites small regions of the dye until they get so hot they decompose, while leaving other areas completely untouched. Hence, the ones and zeros of digital data. It also explains why the disc is so hot once it comes out of the drive.

Many azo dyes are also food-safe; they’re responsible for the Mountain Dew’s yellowish tint, the bright red of Swedish Fish, and so much more. As pollutants, they can be filtered out through processes as diverse and novel as irradiation and electrocoagulation, where dyes form clumps in the presence of an electrical field. Meanwhile, some of the lowest-cost solar cells have relied on the strong absorbance of azo dyes. So, look over your OChem notes and give the azo compound the credit it deserves. Just because you aren’t tested on it doesn’t mean it isn’t important.



# The Do-It-All Liquid

by: Jordan Leventhal, *Contributing Author*

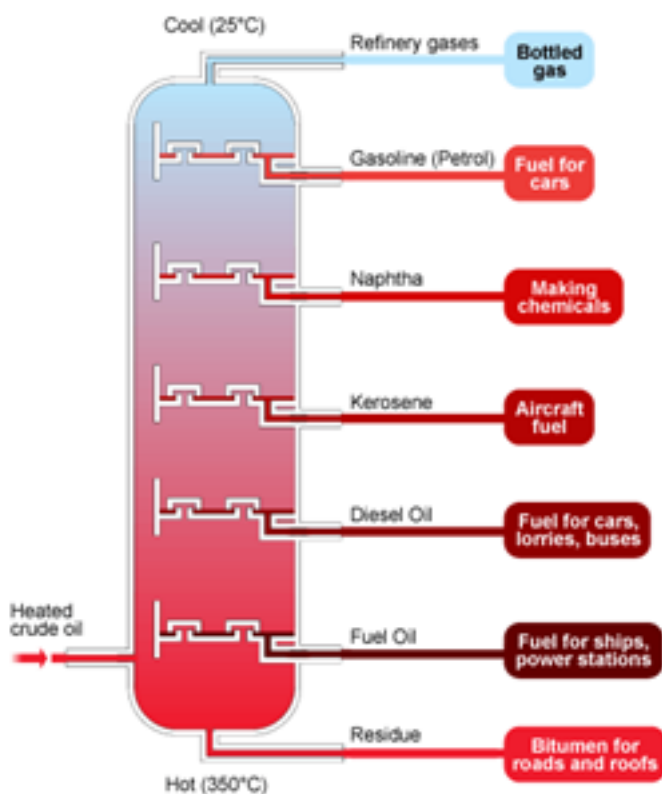
When most people think about oil, they think about gasoline. The result is that most conversations about oil revolve around cars and trucks. In reality, the oil that is extracted from the ground, known as “crude oil,” contributes to a great deal more than just cars and trucks. Crude oil goes through a rigorous refinement process during which it is separated into its various components which are used in a variety of important applications worldwide.

Before refinement, crude oil is a black, viscous liquid, comprised of hydrocarbons of varying length. The goal of refinement is to separate these hydrocarbons based on length. Longer hydrocarbon chains exhibit stronger intermolecular forces (in particular van der Waals forces), so they require more energy to break up molecules into a gaseous state. Thus, longer hydrocarbon chains will have higher boiling points than shorter chains. This property is exploited at oil refineries in a process called fractional distillation.

Fractional distillation, depicted in Figure 1, begins with vaporizing the crude oil mixture and pumping it into a column. The column has a temperature gradient which causes lower molecular weight hydrocarbons to condense at higher chambers within the column. The result is a separation of crude oil into mixtures of hydrocarbons of similar length, termed “fractions.” The fraction that most people are familiar with is gasoline, which is blended and used to fuel cars and trucks. However, the other fractions produced from the distillation of crude oil are indispensable in a number of industries.

The gas that comes off of the top of the column is known as bottled gas and consists of the shortest carbon chains. Butane and propane are examples of bottled gas and are commonly used to heat homes and for use in gas stoves. Naptha, a classification for a grouping of slightly longer hydrocarbons, is commonly used to form alkenes which are used to produce the polymers used in various plastics. Kerosene, diesel, and fuel oil are all used as heavier fuels for large scale combustion engines in aircraft, trucks, ships and power stations. Fuel oil is also used for the production of lubricating oils that are used in the majority of industrial processes. Finally, the thick residue at the bottom is used in road and roof surfaces.

Looking to the future, it is clear that a variety of industries will be affected by the oil industry. Volatility in oil prices, unrest in the Middle East, deep sea oil spills, and the onset of carbon induced climate change have created uncertainty in the long term viability of this precious resource. As the world begins to look for new technologies to reduce our reliance on oil it is important to remember that the barrel does not stop at gasoline. In other words, as scientists and entrepreneurs, we should not focus exclusively on clean power, electric cars, and battery technology—it is important to focus investment and research into alternatives for all of the products that are sourced from crude oil.



**Figure 1.** Fractional Distillation of Crude Oil