



CALIFORNIA STATE SCIENCE FAIR 2017 PROJECT SUMMARY

Name(s) Anshika Agrawal; Stuti Agrawal	Project Number S0601
Project Title The Most Effective Antacid	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Several antacids were tested in this experiment to determine the pH range in which they show buffer activity. Since the desired maximum or minimum hydrogen ion concentration may differ for various clinical conditions, the minimum pH attained, the speed of neutralization, the buffer capacity, and the length of activity at any desired pH value were studied. Four commercial antacids: Tums, Roloids, Alka-Seltzer, and Zantac- were considered and used as variables in this project. Through this project, we tried to find the fastest reacting antacid which could help soothe the stomach the quickest.</p> <p>Methods/Materials Beakers, Graduated Cylinders, Glass Stirring Rod, Electronic Scale/Analytical Balancer, Hydrochloric Acid, DI Water, Antacid Tablets, Burette, Weigh Boats, Mortar and Pestle, Ring Stand, Burette Clamp, Funnel, Magnetic Stir Bar, Universal Indicator, pH Indicator, pH Meter, pH Recorder, Clamp for pH Meter</p> <p>Clean all glassware, make solution of antacids in water, set aside, dilute HCl and pour into the burette, slowly stir the antacid water solution with a magnetic stirring machine, slowly titrate the solution and record the pH. Repeat</p> <p>Results In the end, we found that Zantac was the best antacid and that our initial hypothesis was wrong. We had first guessed Alka-Seltzer because from previous knowledge, we knew that it rapidly dissolves in water. However, we were wrong and we chose Zantac to be the fastest because it had the quickest drop in pH and took the least amount of acid to have a change of 2 in the pH levels.</p> <p>Conclusions/Discussion This concept is not only applied towards the use of antacids to help reduce the pain in the stomach due to acidity, but also help us further understand and solve problems arisen due to ocean acidification. Through our experiment, we found out that over the counter antacid products such as Tums and Roloids, both are made mostly of calcium carbonate. Calcium plays a major role in helping stop heartburn and acidity by tightening the valve that keeps stomach acid in its place. Therefore, if it forms of calcium can help in neutralizing acids, then calcite (a constituent of limestone) should be able to help the ocean. It is the most stable form of calcium carbonate and it could possibly neutralize emission-based acids in the atmosphere/oceans and can cool the planet. Oyster shells are made from calcium carbonate, so they act an antacid pill for the ocean.</p>	
Summary Statement We created an experiment which depicted the fastest reacting antacid out of the four most commonly used, over the counter tablets.#	
Help Received We received help from our marine biology teacher, Ms. Camacho and our chemistry teachers, Mr. Monge and Mr. Paris. This project was completed in the school's science laboratory.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Josef Alavi	Project Number S0602
Project Title Application of Nanostructured Porous Silicon as an Electrical Biosensor for Alzheimer's Screening	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The goal of my research project was to create reusable electrical biosensors which utilize nanostructured porous silicon as a substrate to accurately measure the concentrations of two peripheral biomarkers: alpha 2 macroglobulin (a2M) and complement factor H (CFH). Both biomarkers have high correlation (in independent studies) with Alzheimer's disease</p> <p>Methods/Materials Fabricated nanoporous silicon by electrochemical etching in HF solution. Functionalized nanoporous silicon with aminopropyltriethoxysilane (APTS) and antibodies against CFH and a2M protein. Measured altered electrical conductivity following incubation in known concentrations of CFH and a2M with a picoammeter. Used a pH shift with Glycine-HCl pH 3 to elute protein binded to the biosensors.</p> <p>Results Between 2 and 5.5 volts, the electrical biosensors for a2M and CFH were non-ohmic and exhibited an exponential relationship ($R^2 > 0.94$). Following a sudden increase in current, the electrical biosensors exhibited high linearity between protein concentration and electrical current at voltages ranging from 6.5 to 7.5 ($R^2 > 0.98$). Furthermore, incubation in protein elution buffer (0.2 M Glycine*HCl at pH 3) removed over 94% of immobilized protein from the used electrical biosensor, allowing the electrical biosensor to be reused.</p> <p>Conclusions/Discussion The linear calibration curves for a2M and CFH allow for linear interpolation of unknown quantities of each protein, making the electrical biosensors suitable for measuring a2M and CFH concentrations in human serum. The ability to accurately measure unknown protein concentrations of a2M and CFH using the reusable biosensor may allow the peripheral serum biomarkers to reliably screen Alzheimer's disease.</p>	
Summary Statement I successfully fabricated and characterized reusable porous silicon biosensors to interpolate unknown concentrations of Alzheimer's implicated a2M and CFH ranging from 25 to 50 ug/ml.	
Help Received I used the facilities at the Buck Institute for Research on Aging to conduct my research project.	



CALIFORNIA STATE SCIENCE FAIR 2017 PROJECT SUMMARY

Name(s) Sabrina Asefi; Anne Berg	Project Number S0603
Project Title The Effect of Different Sunscreens (Baby, Kids, Lotion, Spray, and Stick) on the Amount of UV Rays Protected by Your Skin	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals This project was done in the effort to find the difference between each form of sunscreen and how well the different types protected the skin. The sunscreens used for this experiment all had the same SPF, which was a scale that helped give an estimate of the time the synthetic skin can be in the sun.</p> <p>Methods/Materials The materials required for the experiment were mainly, the different types of sunscreens, provided by the Banana Boat Company, the ballistic gel, which was provided by the Barry Farm Company, and the sun sensitive paper, which came from Sun Art. The ballistic gel was laid on top of the UV paper and the sunscreen was evenly distributed onto the ballistic gel which acted as a synthetic skin. Then after 5 minutes, the color on the UV paper was recorder to measure the amount of protection each type of sunscreen had, based on its shade on the UV paper. The darker the shade, the less in protected. The amount of time was controlled to be the same for each trial. The experiment consisted of three tests in order to make sure that the data collected was the most accurate data possible.</p> <p>Results The experiment resulted in the Banana Boat Kids and Banana Boat Baby sunscreen to be the most protective. Following the kids and baby sunscreen, the stick sunscreen was proved most protective, and lastly the lotion sun screen, followed by the spray sunscreen. These results supported the hypothesis of the experiment to be true. The reason the baby and kids sunscreen was shown to be most protective was because that sunscreen is designed to protect their sensitive skin. The results concluded that children and baby's skin is well protected, as well as the face. Overall the deviation was low, almost all were around 0%. The deviation for the kids and baby sunscreen were both 0%, while the deviation for both lotion and spray were 6.7%.</p> <p>Conclusions/Discussion The hypothesis formed before the experiment was supported by the data. From the results of this experiment, it can be concluded that the kids and baby sunscreen were the most protective, followed by the stick and lotion form of sunscreen, and then the spray can last in the amount of protectiveness. These results also showed consistency which supported the idea that sunscreen is a reliable source of protection. The belief that the kids and baby sunscreen was the most protective was because of the ingredients used to protect children's and baby's sensitive skin.</p>	
Summary Statement Our project was done in effort to discover the difference in the amount of UV rays protected from your skin between different forms of sunscreen.	
Help Received We would like to acknowledge our parents for assisting us in the process of our experiment, and giving us ideas that helped improve our project. They also supplied all materials that were needed in order to perform the experiment. Additionally, we would also like to thank Ms. Herrman for helping us format our	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Sakina Bambot	Project Number S0604
Project Title Study of the Degradation Mechanism of Contact Lenses: Investigation Using TOF-SIMS	
Objectives/Goals The objective of this experiment was to study the degradation mechanism of 30-day contact lenses by using the TOF-SIMS technique. The goal was to understand why contact lenses got uncomfortable towards the end of the thirty days.	
Abstract Methods/Materials The contact lenses were rinsed with distilled water and the ring finger was gently run across the lens# surface 7x, 14x, 21x, and 28x while fifth lens was kept untouched. Each rub simulated one day of wear. Each lens was inserted into the TOF-SIMS instrument. The data was collected from the center of the lens using a square region of 150 microns x 150 microns. Next, using an Argon cluster gun setting a square crater of 500 microns x 500 microns was etched onto the surface and a spectrum from the surface created a depth profile that was collected until the signal from the material of the silicone lens had become stable. Nitrogen containing fragments were indicative of the hydrophilic coating (mass 112 C(6)H(10)NO) and a silicon-containing fragment indicated the core material of the lens (at mass 73 C(3)H(9)Si).	
Results The point at which the mass 112 (C(6)H(10)NO) and mass 73 (C(3)H(9)Si) fragment ions intersected was used as an indicator of the coating being depleted. The time at which the two fragment ions intersected became shorter when going from 0 to 7x to 14x to 21x and then to 28x indicating that the hydrophilic coating on the contact lens was becoming thinner with wear.	
Conclusions/Discussion The new lens had a much thicker hydrophilic coating than compared the coating of 28x lens, showing that the 30-day wear contact lens coating is not immune to degradation and is delicate. This research helps understand the wearing down of long-term contact lenses.	
Summary Statement Using the TOF-SIMS technique, I simulated wearing a 30-day contact lens throughout the month and found that the coating of the lens became thinner with wear.	
Help Received I used the TOF-SIMS instrument at Evans Analytical Group under the supervision of Dr. Ginwalla who taught me how to use it.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Sabeeha F. Baqui	Project Number S0605
Project Title Efficient Water Electrolysis to Fuel Our World	
Abstract Objectives/Goals Renewable energy is one of the major themes of research today; scientists are working on energy types such as solar energy, hydrogen fuel cells, and hydroelectric power, but the ultimate goal of renewable energy is to be able to create an efficient and constantly available source of power. An idea that has recently come up in scientists' search for renewable energy is the electrolysis of water. Scientists have long known that the separation of water and hydrogen molecules has the potential of creating high energy chemical energy, but they lacked an efficient catalyst for this reaction. The search led them to cobalt, used in the form of cobalt nitrate in the experiment. The purpose of this experiment is to test the change in efficiency that results due to the addition of a catalyst, and explores the potential of these added compounds to lead to a greener industry. It is hoped that this experiment and others like it will increase public awareness about the importance of this discovery to the renewable energy industry, and increase the possibility of this becoming a worldwide used power source.	
Methods/Materials I conducted this experiment with a simple circuit on a breadboard, consisting of a nine volt battery and a resistor, which is hooked up to an electrochemical cell. While conducting the experiment, I first began by taking a reading of the battery voltages only, and then connecting up the electrochemical cell with the phosphate buffer and measured again, before the addition of a catalyst. Afterwards, I added the catalyst and measured the voltage for each nitrate salt and each resistor value.	
Results Overall, I found that my hypothesis had been proved correct, and that the efficiency of the reaction was greatly increased after the addition of the catalyst. I also found that the better functioning resistor was the 10K ohm, and that silver nitrate is the best catalyst.	
Conclusions/Discussion The applications of this device are many, but the main concern of this experiment was improving the catalyst used to power hydrogen cars. This source of power can also eventually be utilized to power homes and industries.	
Summary Statement My project concerns finding effective catalysts for a new, efficient, and environmentally-clean form of energy.	
Help Received science teacher, Ms. Hajar Ibrahim	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Jake D. Bringetto	Project Number S0606
Project Title Improving Photoelectrochemical Decomposition of Water Using Earth Abundant Metal Oxide Catalysts	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Electrochemical deposition (electroplating) of earth abundant, metal-oxide catalysts to electrodes will increase the hydrogen production during photoelectrochemical decomposition of water, by increasing the rate of reaction.</p> <p>Methods/Materials Nickel-iron oxide and cobalt-iron oxide were selected, due to their potential catalytic properties, to increase the rate of reaction of the decomposition of water. After electrochemical deposition of the chosen catalysts, a photovoltaic (PV) panel was utilized for the PV/electrolysis of water.</p> <p>Results The nickel-iron oxide catalyst allowed for a 23.5% faster rate of reaction than the control and the cobalt-iron oxide catalyst allowed for a 27.5% faster rate. Energy required for a chemical reaction to occur was 13.5% less with the nickel-iron oxide and 16% less with the cobalt-iron oxide than that of the control.</p> <p>Conclusions/Discussion Given the current demand from the \$100 billion hydrogen industry and the potential of the hydrogen based fuels of a clean energy future, the need for more efficient methods of hydrogen production, using renewable energy sources, are vital. Experimental data suggests that the application of low cost, earth abundant catalysts increases the rate of reaction and lowers the energy demands of photoelectrochemical water splitting. Research and development in the area of artificial photosynthesis provides effective hydrogen production techniques to support the growing hydrogen economy using renewable energy sources.</p>	
Summary Statement Using a biologically inspired method of converting sunlight into stored energy, this project seeks to increase the efficiency of photoelectrochemical decomposition of water using earth abundant, metal-oxide catalysts.	
Help Received	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Connor Brock; Sarah Ann Frank	Project Number S0607
Project Title Photocatalytic Reduction of Hexavalent Chromium Using Titanium Dioxide Catalyst with UV-Irradiation	
Abstract Objectives/Goals Investigation of the chemical structure of hexavalent chromium through multiple experiments and changing variables regarding the remediation through the use of the catalyst, titanium dioxide. The objective of these experiments is to investigate possible methods of decontaminating drinking water sources that have damaged communities both locally and nationwide. Goal is to find a method in which hexavalent chromium will be reduced in a short amount of time to a safe amount. Methods/Materials Creating hexavalent chromium samples using potassium chromate, deionized water, phosphate buffer, and silver-doped titanium dioxide catalyst. After experiments, hexavalent chromium levels were tested using 1,5-Diphenylcarbazide and running through a spectrophotometer at 540 nm. All material were provided by a chemical and environmental engineering lab. Results After absorbance levels of hexavalent chromium were measured through the spectrophotometer, it was found that reduction speed was most effective at an acidic pH as opposed to a neutral pH, and the catalyst was most effective at one percent silver relative to titanium dioxide, as opposed to one-hap percent, two percent, and five percent. Conclusions/Discussion Reduction rate of hexavalent chromium is most effective at an acidic pH due to the reaction product being soluble trivalent chromium, which dissolves in the catalyst solution and allows for more catalytic sites. At a neutral pH, the reaction product is insoluble chromium(III) hydroxide, which precipitates on the catalyst surface, disrupting the catalytic sites. The one percent silver titanium dioxide catalyst worked best because at lower percents, there was simply not enough catalytic sites generated, and at higher percents, the excess silver recombines the electron hole, or catalytic sites of reduction, effectively reducing the rate of reaction.	
Summary Statement An investigation on how to quickly and effectively reduce the toxic carcinogen hexavalent chromium from the public's drinking water.	
Help Received Gongde Chen, graduate student at the UCR Chemical and Environmental Engineering Department aided with correct experimental and safety procedures. All materials were provided by the Chemical lab at UCR.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Tian Chen; Frederick Nitta	Project Number S0608
Project Title Graphene Spintronics: Density Functional Theory Study of Fe, Co, Ni, and Pt Embedded Graphene	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals By utilizing the plane-wave function of Density functional Theory, we performed relaxation calculations to investigate electronic and spintronics potential of Fe, Co, Ni, Pt atoms+dimers+combinations embedded graphene.</p> <p>Methods/Materials We used Quantum Espresso for all calculations; it is an open-source software that utilizes Density Functional Theory to study solid state systems. When given the necessary parameters in the input files for our various configurations, the software calculates charge density, band structure, density of states, etc. We also used Visual Molecular Dynamics, a molecular visualization software, to understand the geometric properties.</p> <p>Results Analyzing single atom complexes, we found Co-C30 had the lowest embedding energy, thus the most stable, followed by Fe-C30, Ni-C30, Pt-C30. The geometric data did not fully support the results of the embedding energy data. For the single metal, the geometric data showed that Fe-C30 or Pt-C30 had the longest metal-carbon bond, followed by Co-C30 and Ni-C30. Both double metal complexes had higher embedding energies than the single metal configurations, therefore, less stable. The diagonal configurations have lower embedding energies than the side configurations, so they would more stable and are better for applying it in spintronic data storage devices. Magnetization data show that Co and Fe embedded in graphene have potential for spintronic data storage, because of its magnetization localized on the metal atom. However, Ni and Pt embedded in graphene cannot be used for data storage, because of their lack of magnetization when looking at both the single metal atom and double metal atom configurations.</p> <p>Conclusions/Discussion Graphene complexes embedded with Co and Fe show high potential for spintronic data storage, while Ni and Pt shows little promise. In the future, we will analyze band structures to further understand the magnetization properties of the material. More configurations with metals of similar periodic properties will be experimented to examine its properties.</p>	
Summary Statement By utilizing the plane wave function of Density functional Theory, we performed relaxation calculations to investigate electronic and spintronics potential of Fe, Co, Ni, Pt atoms+dimers+combinations embedded graphene.	
Help Received We developed the idea of the project, and consulted Mr. Harman Johll of Singapore National Junior College to guide us through the theoretical nuances of Density Functional Theory and provide helpful tips when using Quantum Espresso. We were mentored by Dr. Glenn McGee of Palo Alto Unified School	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Lianna M. Daug	Project Number S0609
Project Title Waste Coffee Grounds as Green Inhibitor of Zinc Corrosion in Hydrochloric Acid Solution	
Abstract Objectives/Goals This project investigated the inhibitory properties of aqueous extracts of waste coffee grounds (WCG) on the corrosion of zinc in HCl. The effects of extract concentration and immersion time on the inhibition efficiency (I.E.) of WCG were studied. Methods/Materials Zinc corrosion was achieved by immersing a Zn strip in 1M HCl with and without WCG. Corrosion was measured using hydrogen gas evolution and weight loss measurements. Volume of H ₂ gas produced was determined using a gas collecting apparatus. Readings were done at 10 min. intervals for 2 hrs for Control vs low, medium, and high dose WCG. Weight loss studies were carried out for Control vs best inhibitor concentration. A pre-weighed zinc strip was immersed in HCl, and reweighed at 2 hr intervals for 24 hrs. I.E. and corrosion rate were calculated as a function of time. Results H ₂ gas evolved decreased markedly with addition of WCG. Higher concentrations led to decreasing volumes of H ₂ gas. I.E. % was determined to be 82, 86, and 91 for low, medium, and high dose WCG respectively. For the gravimetric study, weight measurements could not be done past 8 hrs for Control because the zinc was too corroded to weigh by the 10th hr. With high dose WCG, even after 24 hrs of immersion, weight loss was only 12.8g from initial weight of 37.9 grams. I.E.% of WCG extract was 93, 95, 94, and 93% for 2,4,6, and 8 hrs of immersion time. At the 8th hour, corrosion rate was 2,819 mm/year without WCG vs 213 mm/year with WCG. High I.E. was maintained through 8 hrs but could not be calculated past 8 hrs. There was good agreement between I.E. values obtained via gasometric and gravimetric methods, with 90.9 vs 92.7% I.E. for high dose WCG at the 2-hr mark. Conclusions/Discussion WCG extract was effective in inhibiting Zn corrosion in HCl. I.E. increased with higher concentrations of the extract. High I.E. was maintained through 8 hrs but no conclusions could be made for longer immersion times. This study shows evidence that WCG has good corrosion inhibiting properties and the fact that it is a readily available and eco-friendly waste product makes it an attractive alternative to currently used corrosion inhibitors.	
Summary Statement Through hydrogen gas evolution and weight loss measurements, waste coffee ground extract was proven to be an effective corrosion inhibitor of zinc in HCl, and efficiency increased with higher extract concentrations.	
Help Received My mother supervised handling of hydrochloric acid. I designed and performed the experiments myself.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Lauryn A. Decker	Project Number S0610
Project Title Capturing CO2	
Abstract Objectives/Goals To determine if the concentration of a calcium hydroxide solution (limewater) affects how much carbon dioxide it can capture. Methods/Materials Limewater with different concentrations (0%, 25%, 50%, 75%, 100%) were placed in beakers and their initial pH level was recorded. Then, carbon dioxide was bubbled through the different concentrated limewater solutions (calcium hydroxide) and the final pH level of each was taken. Then the pH levels were converted to the concentration of the calcium hydroxide. Then, the difference between the initial and final concentrations was calculated and converted to the grams of carbon dioxide captured for each trial of each concentration. Results 0% limewater averaged about 4.15×10^{-8} grams while 50% limewater averaged about 8.91×10^{-2} grams. However, 100% concentrated limewater captured the most carbon dioxide averaging about 3.30×10^{-1} grams of carbon dioxide. These results prove that different concentrations of calcium hydroxide solutions affect how much carbon dioxide they can capture. Conclusions/Discussion These results support the hypothesis that 100% concentrated limewater would capture the most carbon dioxide. This project shows that there are many different ways to capture carbon dioxide. Therefore, this could help many organizations who are trying to capture carbon dioxide capture it more efficiently. For example, these results could be used when creating a carbon dioxide absorbing tower because it would provide the best carbon dioxide absorbent material.	
Summary Statement This project determines if the concentration of a calcium hydroxide solution affects how much carbon dioxide it can capture.	
Help Received My chemistry teacher, Mrs. Reed, taught me about the calculations/procedure and provided me with the materials I needed.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Daniel S. Fishman	Project Number S0611
Project Title Renewable Energy from the Oceans: Optimizing Hydrogen Electrolysis in the Solar/ Fuel Cell Energy Cycle	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals This experiment seeks to expand our knowledge of cost-effective, renewable energy for populations living near salt water. Specifically, it aims to determine how the efficiency of hydrogen electrolysis, a storable intermediate in the Solar - Fuel Cell Energy Cycle, is affected by differences in solutes, conductivity, reactivity and voltage.</p> <p>Methods/Materials 144 trials involving different combinations of solute concentration (ocean, NaCl, tap & pure water), conductive elements (Al, C, Cu, Pt, Ti, Zn), and voltage (9.0v and 12.0v solar cells) to determine efficient methods to electrolyze hydrogen. Recorded measurements included: solar cell voltage, time to electrolyze a given quantity of H₂ (a measure of efficiency), and observations of electrolysis and reactivity for each sample.</p> <p>Results Greater solute concentration proved positively correlated with efficiency. Pure water generated no H₂, while water with a concentration of 12.0 g NaCl per 404.8 mL produced more H₂ across metals tested (eg, Al at 12.0v produced 2.0 mL of H₂ in 2.6 minutes with a SD of 0.1 while Ti did the same in 13.5 minutes with a SD of 0.3). Interestingly, ocean water with a higher concentration of NaCl was less efficient than pure NaCl water. The most efficient metal element was Al, and the least efficient was Ti across trials. Though Cu is highly conductive, it readily reacted and lost surface area, while Al did not noticeably react during the trials and preserved surface area. Higher voltage improved efficiency across metals.</p> <p>Conclusions/Discussion Based on the experiment results, ocean water is an efficient, naturally-occurring solution for production of H₂ via electrolysis when combined with a commonly-available, corrosion-resistant Al electrode. This combination, along with power from a low-cost, 12.0v polycrystalline solar cell, produces sufficient H₂ during daylight hours when combined in series with 16 like electrodes to power a 1.0v LED light during nighttime hours using a PEM fuel cell consuming 7.0 mL of H₂ per minute. This Solar - Fuel Cell Energy Cycle is renewable, relatively low cost and has no moving parts. It is also independent of any electrical distribution, so the technology can be used by populations in developing economies that have access to ocean water (which covers ~70% of the surface of the Earth). The technology also has the potential to produce pure drinking water as a clean by-product.</p>	
Summary Statement The oceans hold great promise as a distributed source of electrolyzable hydrogen, a storable intermediate in the Solar - Fuel Cell Energy Cycle, considering the impact on efficiency from differences in conductivity, reactivity and voltage.	
Help Received None	



CALIFORNIA STATE SCIENCE FAIR 2017 PROJECT SUMMARY

Name(s) Philippe Hansen Estruch	Project Number S0612
Project Title Design of Biodegradable Energy Source to Power Wearable Electronics	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Power sources such as batteries and capacitors are used everywhere in our electronic devices. Most are, however, rigid, heavy, and cannot be disposed off easily. A power source that is flexible, lightweight, and biodegradable would have broad applications in the field of wearable and medical (sensors) electronics. This work was aimed at developing an energy power source with low cost biodegradable components.</p> <p>Methods/Materials To create the power source, the conducting polymer poly(3,4-ethylenedioxythiophene) - poly(styrenesulfonate) (PEDOT:PSS) commonly used in electronic board circuits was selected because it behaves like a solid electrolyte with both ionic and electronic conduction properties thus with the potential of behaving like a battery and capacitor. To enhance its energy storage capabilities, additional components known to change PEDOT:PSS microstructure, were tested at various ratios: glycerol, polyethylene glycol, and dimethyl sulfoxide. In addition, the plant-based cellulose were added to the mixture in an attempt to create a strong and stable structure. The newly created composites were compared for capacitance and resistance. Composite preparation protocol included a pre-heating step of the mixture to increase reagent homogenization, casting of the slurry into plates followed by baking. All measurements were performed in triplicate using a capacitance and resistance meter once the slurries had solidified into hydrogels.</p> <p>Results A novel power source was created using biodegradable materials only. The highest energy storage performance (capacitance in the range of 1000 nF) was obtained with PEDOT:PSS mixed with cellulose and glycerol (ratio: 0.7, 0.7, 12.5 v/v%, respectively) in 3.5-cm diameter discs, a level sufficient to operate a light bulb when fully charged demonstrating its potential application.</p> <p>Conclusions/Discussion Unlike batteries and capacitors currently available, this composite is produced from simple materials, paper and polymers not requiring any dangerous chemicals or heavy metals and the preparation process is simple, cheap and possibly scalable to produce larger waffles with higher capacitance. Given its current properties, this power source should be capable of powering small devices such as glucose sensor, pacemakers, and computer components.</p>	
Summary Statement I created an efficient biodegradable energy power source composite.	
Help Received I designed the experiments and created the composite myself. My physics teacher, Mr. Danssaert, provided me with some materials (circuit board, capacitor) and my San Diego Science Fair coordinator teacher, Mr. Haas, supported me with encouragement. I used a bench at the laboratory of Vetica Labs to	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Jorden R. Harber	Project Number S0613
Project Title The Effect of Temperature on the Equilibrium in the Production of Biodiesel	
Abstract Objectives/Goals For my project, I wanted to determine at which temperature of production of biodiesel would result in the greatest yield of the reactants (catalyzed methanol and soybean oil) into the products (biodiesel and crude glycerol). The temperatures I tested were 30, 45, 60 75, and 90 degrees celsius. Using Le Chatelier's Principle, I hypothesized that the biodiesel produced at 30 degrees celsius would have the highest conversion rate of soybean oil to biodiesel, thus resulting in the greatest yield of biodiesel. Methods/Materials First, I made a catalyzed methanol mixture with the potassium hydroxide. I completed a trial for each temperature. For stage one of the trial, I heated soybean oil to the specific temperature and added catalyzed methanol. I let it react at the specified temperature for sixty minutes and then placed the solution in a separatory funnel to separate into an upper biodiesel phase and a lower crude glycerol phase for twenty minutes. I took out the crude glycerol phase and weighed it for my future calculations. For stage two of the trial, I repeated the process exactly. This was the end of my trial. To complete my calculations, I first found the moles of soybean oil used and the theoretical glycerol yield. I then found the actual glycerol molar yield and overall soybean oil conversion for stage one and stage two. Results My biodiesel produced at 30C had a 98% conversion rate, at 45C had a 66% conversion rate, at 60C had a 93% conversion rate, at 75C had a 59% conversion rate, and at 90C had a 0% conversion rate. Conclusions/Discussion My hypothesis was supported because the biodiesel produced at 30C had the highest conversion of products to reactants. There was an overall trend of higher temperature having lower conversion rates with the exception of 60C. In both my 60C trial and my 90C trial my biodiesel phase and glycerol phase would not separate and instead turned into soap. The weight of the crude glycerol was higher than it was supposed to be because the crude glycerol phase also had soap in it. For the 90C trial, so much soap was created so a value for the crude glycerol was impossible to obtain, thus resulting in the 0% conversion. It is useful for the biodiesel production industry to know that lower temperatures lead to a higher yield of biodiesel.	
Summary Statement My project investigates which temperature of production produces the highest yield of biodiesel in accordance to the equilibrium rules of Le Chatelier's Principle.	
Help Received My chemistry teacher Dr. Rano Sidhu helped me understand the characteristics and importance of chemical equilibrium.	



CALIFORNIA STATE SCIENCE FAIR 2017 PROJECT SUMMARY

Name(s) Charles J. Huang	Project Number S0614
Project Title Characterization of 2D Molybdenum Disulfide Crystal Growth for Nano-Optics and the Extension of Moore's Law	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of this research is to optimize the Chemical Vapor Deposition synthesis method of 2D Molybdenum Disulfide by analyzing the effect of Molybdenum Oxide to Sulfur Precursor on crystal thickness. Currently, 2D MoS₂ is a very new material in an early R&D phase. With the optimization of CVD growth conditions, a larger database of MoS₂ crystallization can be generated for large scale production of MoS₂.</p> <p>Methods/Materials Molybdenum oxide (MoO₃) and sulfur in varying molar ratios were prepared onto glass boats. The prepared SiO₂ wafer was put on top of the molybdenum oxide and the two boats of MoO₃ and S were placed inside the CVD furnace at specified locations based off the heat distribution. The furnace settings and the argon gas flow were modulated where the CVD would heat up to 650° C then cool back down to 100° C, where crystals were extracted. The crystals were analyzed at the 100 micrometer level with a Horiba LabRAM. Photoluminescence (PL) spectra and Raman spectra were taken for analysis of monolayer, bilayer, trilayer, or bulk crystal growth.</p> <p>Results Through the analysis of the PL and Raman Spectra, a higher molar ratio of MoO₃ to Sulfur was correlated with more monolayer crystal growths. Specifically, ratios 0.252 to 0.332 had the most prominent single layer crystals. Samples 1 and 2, which had lower ratios, grew in trilayers and bilayers respectively. Additionally, sample 5 showed anomalous wire-structured MoS₂ growths and an abnormally high and near-single wavelength photoluminescence. Further analysis showed that a water impurity caused the odd crystals to grow.</p> <p>Conclusions/Discussion From this data, multiple conditions with higher precursor molar ratios in MoS₂ CVD synthesis were shown in effect to their crystallization. By showing which ratios of MoO₃ to Sulfur precursors allowed for monolayer and multilayer crystals, the CVD synthesis can be exactly tailored to specific crystals required in Van Der Waal heterostructures, which are composed of multiple stacked 2D materials. Because multilayer MoS₂ materials have different band gaps, the data gathered in this experiment can be used to grow MoS₂ crystals specific for optoelectronic devices that emit or detect specific wavelengths of light. In addition, exact ratios for monolayer growths are crucial in the advancement of MoS₂ MOSFETs for the extension of Moore's Law beyond silicon's 5nm gate limit.</p>	
Summary Statement I varied the ratios of MoO ₃ to sulfur precursor in a CVD synthesis method and analyzed the effects on growth of monolayer/multilayer MoS ₂ crystals.	
Help Received I conducted the research at the Zhang lab at Berkeley. Mervin Zhao, a graduate student, taught me how to use the CVD furnace. In addition, he guided me through the process of how to take Raman and photoluminescence spectra using the Horiba LabRAM.	



CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s) Saehui Hwang	Project Number S0615
Project Title Effects of Temperature Variation in a Two Pot Synthesis of Polyol Using Benzoic Acid	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Using vegetable oil to make polyurethane foam is gaining interest to make foam renewable and biodegradable. This research project is designed to test if polyol (a precursor of polyurethane) synthesis is possible using a plant based acid, benzoic acid. It also tests the effects of reaction condition variation in the efficiency of polyol formation.</p> <p>Methods/Materials The two-pot synthesis procedure involves two steps: epoxidation and the ring-opening step. Benzoic acid was used in the ring opening step. The reaction time and temperature was varied and the produced polyol was scanned through a Fourier Transform Infrared Spectrometer. The alcohol peak heights were then analyzed and interpreted as the amount of polyol formed.</p> <p>Results In contrast to previous papers, more polyol was formed at a lower temperature, i.e. 70 degrees Celsius, instead of 80 degrees. This suggests side reactions from the epoxide. More polyol was obtained in 3 hours than 5 hours at the same temperature, suggesting a continued reaction pathway of polyol. The polyol efficiency did not vary between 3-hour and 5-hour reaction times for 60 degrees Celsius.</p> <p>Conclusions/Discussion For the first time in polyol research history, this experiment showed that the production of polyol is possible through benzoic acid. It suggests that while benzoic polyol is the favored kinetic product under certain conditions, it is not the thermodynamic product. It also suggests that 70 degrees Celsius and 3 hours is the optimal reaction condition for the ring opening step, and that 60 degrees Celsius is below the energy threshold required to produce polyol. Such findings open possibilities for an entirely plant based foam using benzoic Acid.</p>	
Summary Statement For the first time in research history, this experiment showed that the production of polyol is possible through benzoic acid, which opens up exciting possibilities for increased biodegradability of polyurethane foam.	
Help Received Jahan Dawlaty, Jonathan Ryan Hunt, Marissa Tessman, Peter Starodub, USC, UCSD	



CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s) James G. Karroum, II	Project Number S0616
Project Title Photocatalytic Degradation of Dyes Using Metal Oxides In the Presence of UV Light	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals In this project I determined which metal oxide photocatalysts are most effective at degrading various organic dyes at different concentrations. My hypothesis was that if metal oxide suspended in a dye solution is exposed to ultraviolet light, then the dye will photocatalytically degrade, indicated by a decrease in concentration; TiO₂ will be more effective than ZnO as a photocatalyst, and the rate of degradation will be higher at greater initial dye concentrations.</p> <p>Methods/Materials My variables were the type of metal oxide, type of dye, and the dye's initial concentration. I prepared eight suspensions of metal oxide in dye solution, at different dye concentrations: metal oxides were either TiO₂ or ZnO, dyes were either methylene blue or methyl orange, and dye concentrations were either equivalent to one drop of 1% solution per 100 mL, or two drops. I created every possible combination of these three variables. I then exposed the mixtures to ultraviolet light for two hours, and every thirty minutes extracted a specific amount, separating solid from solution using a centrifuge.</p> <p>Results After measuring and plotting absorbance of solutions using a spectrophotometer, I observed that concentrations of dye solutions generally decreased with time, supported by visual evidence of color loss. Solutions in the presence of TiO₂ and ZnO degraded at comparable rates, but in most instances ZnO was more effective.</p> <p>Conclusions/Discussion Most of my hypothesis was proven correct: the presence of metal oxides allowed ultraviolet light to degrade the dyes. Contrary to my hypothesis, ZnO was the more effective photocatalyst in most scenarios due to its greater rate of change of absorbance compared to TiO₂. Another part of my hypothesis was proven right in that increased initial concentrations correlated with increased degradation rates.</p>	
Summary Statement I determined which metal oxide photocatalysts are most effective at degrading various organic dyes at different concentrations.	
Help Received My past chemistry teacher showed me how to use a spectrophotometer and a centrifuge, and answered questions I had about lab precautions.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Charlotte Y. Kim	Project Number S0617
Project Title The Fantastic Bioplastic! An Investigation of the Relationship Between Bioplastic Composition and Tensile Strength	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals This project was designed to determine how varying the amount of a specific ingredient that constitute a bioplastic mixture can affect tensile strength. I hypothesized that if more glycerin is added to a mixture of cornstarch, water, vinegar, and glycerin, then a bioplastic with increased tensile strength and flexibility will be produced.</p> <p>Methods/Materials Mold, 40 bioplastics made of cornstarch, water, vinegar, and varying amounts of glycerin, stove to heat the bioplastics for 3 minutes and 3 seconds, testing apparatus to test the bioplastic's tensile strength and deformation, rocks, basket, caliper, foodscale, fishscale, ruler, stopwatch, room temperature room for bioplastics to dry in for 10 days. Measured how bioplastics with varying amounts of glycerin can withstand force and its ability stretch.</p> <p>Results The bioplastic with 1 tsp of glycerin was used as a control. The other bioplastics had increased amounts of glycerin by 1/2 tsp each test trial from that of the control until a total of 3 tsp of glycerin was tested. Each bioplastic had 8 test samples therefore 40 tests in total were ran. The bioplastics used as a control (1tsp) withstood more weight compared to the plastic with 3tsp.</p> <p>Conclusions/Discussion Overall, test data do not support the hypothesis. When more glycerin was added to the bioplastic mixture, tensile strength was significantly reduced. The bioplastic mixture with only 1 tsp of glycerin that was used as a control held 149 psi more stress than the bioplastic mixture with 1½ tsp of glycerin. This showed how much of a difference a small amount of glycerin can affect the bioplastic's properties like tensile strength. Flexibility was also significantly reduced as the amount of glycerin was increased; however, this result could be an indirect result of the bioplastic being weaker and failing under less load. This is because glycerin is a plasticizer. It traps water in the starch chains making the polymer chain molecules bend and slide past each other more easily, which adds to the flexibility of the plastic.</p>	
Summary Statement I showed that bioplastics with increased amounts of glycerin withstand less force compared to a bioplastic with a lesser amount of glycerin.	
Help Received I received help from Sam Kim (my Father) in building and designing the test apparatus.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Vivian Kong	Project Number S0618
Project Title The Quest to Reducing Petroleum Based Pollution: Bioplastic	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Creation of bioplastics based from banana peels and potato starch to combat plastic buildup and pollution. Test the bioplastics for similar qualities to petroleum based plastic.</p> <p>Methods/Materials Tested the durability, biodegradability, and elasticity of each bioplastic. The potato starch produced two different trials, one with glycerin and one without. The banana peels were dipped into sodium metabisulfite as a preservative agent. One trial used HCl and NaOH in a molarity of .1 and the other in .5 with varying concentrations of sodium metabisulfite.</p> <p>Results The bioplastics were successful in forming. The potato starch created superior plastic to the banana peel plastic as it was stronger, did not decompose, and had a more applicable structure for consumer usage. Both plastics held similar qualities to petroleum based plastic, particularly the potato based plastic with a higher weight tolerance and no decomposing.</p> <p>Conclusions/Discussion The objective to create bioplastic and test its qualities was attained as well as obtaining results to which bioplastic has superior qualities. In the potato starch plastic, the trial containing glycerin proved to be stronger. In the banana peel plastic, a higher concentration of sodium metabisulfite decreased the decomposability rate. Through the testing of several trials, potato starch plastic was concluded to have produced superior results to the banana peel plastic. These bioplastics can further enhance the environment as an alternative to petroleum based plastic.</p>	
Summary Statement I created bioplastics made out of banana peels and potato starch as an effective alternative to petroleum based plastic.	
Help Received	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Juwon Lee	Project Number S0619
Project Title Toward a More Thermally Stable Halogen Gas Encapsulation Technique Using Heavy Water Clathrate Hydrates	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Clathrate hydrates are solid crystalline inclusion compounds with host water cages that enclathrate (wrap around or encapsulate) small gas molecules such as halogens or small hydrocarbons such as methane. Methane gas hydrates, which solidify above the freezing point of water, can plug natural gas pipelines. This is a major energy transport problem but also an opportunity to store chemical potential energy in a safe form. Despite extensive study, both experimental and theoretical, the nature of the bonding in gas clathrate hydrates is still not fully understood. The objective was to change the nature of the host cage by replacing normal water with heavy water to increase thermal stability of the clathrate hydrates formed.</p> <p>Methods/Materials Different types of crystalline halogen clathrate hydrates were produced by condensing bromine and chlorine gases in normal water and heavy water in sealed optically transparent sample cells to allow UV-visible spectroscopic interrogation. The solid clathrates were grown on the cooled window of the sample cell. The clathrate hydrates were analyzed using both transmission and reflectance UV-visible spectrophotometers.</p> <p>Results Halogen clathrate hydrates made with heavy water cages showed markedly greater thermal stability (i.e., persisting significantly longer as temperature rose) compared to regular water clathrates. These clathrates could be distinguished by the eye via their distinctive coloration. Halogen clathrate hydrate spectroscopic results showed that the clathrate hydrate spectra were related to but different from both the water-free halogen vapor spectra and aqueous halogen solution spectra.</p> <p>Conclusions/Discussion The heavy water clathrates formed more quickly and disappeared more slowly compared to normal water clathrates as the temperature was lowered and raised. The deuterium oxide clathrate hydrates are therefore more amenable to spectroscopic interrogation than regular water counterparts. Elucidation of the structural properties of clathrate hydrates in different types of water cages helps to further understand and thus better address the challenge of methane clathrate hydrate plugs in natural gas pipelines while also pointing the way to improvements in gas storage and transportation techniques.</p>	
Summary Statement I produced and spectroscopically analyzed halogen clathrate hydrates in normal water and heavy water cages to better understand the host-guest interactions.	
Help Received I thank my research advisor Dr. John W. Kenney III at Concordia University for his support and advice for my project. I also am pleased to acknowledge Dr. Ken Janda and his group at UC-Irvine for providing support, expertise, and materials.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Regina E. Lee	Project Number S0620
Project Title Utilization of Triglycerides from Spent Coffee Grounds to Create Methyl Esters through Transesterification	
Abstract Objectives/Goals Converting lipids extracted from used coffee grounds into usable biodiesel efficiently by using a strong acid catalyst and comparing it to other fuels, such as vegetable biodiesel and Diesel No. 2. Methods/Materials Extracted oil from used coffee grounds using a Soxhlet extractor. Then put the oil through a transesterification process using methanol and Sulfuric Acid as the strong acid catalyst by letting it reflux. After filtering it and taking out the layer of biodiesel, it was put through a GC/MS test to find the concentration of methyl ester groups inside, as well as the percent of biodiesel recovered. The energy density was also found using a calorimeter. Results The coffee biodiesel samples contained about 62.69% biodiesel, while the vegetable biodiesel yielded about 80.1%. They had an average energy density of 2095.71 calories/gram of fuel, while the vegetable biodiesel had 2246.8 cal/g and the Diesel No. 2 had 2265.65 cal/g. Conclusions/Discussion The experiment was successful in that an efficient way of creating biodiesel from used coffee grounds was found. The unwanted residue left behind after the transesterification process was reduced significantly, increasing the yield. The energy density is comparable to that of Diesel No. 2 and vegetable biodiesel. This project also has potential to be produced on a larger scale as most of the chemicals, such as hexane, can be recycled and be used for future processes.	
Summary Statement I created usable biodiesel from waste coffee grounds and found that it compared favorably well to Diesel No. 2 and vegetable biodiesel.	
Help Received My mentors from the Hyperion Treatment Plant taught me about biodiesel and organic chemistry, as well as supplied and taught me how to use the equipment necessary to complete my project. They also oversaw my procedure and helped me when I had questions.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Irene G. Li	Project Number S0621
Project Title Analysis of Novel Carboxymethyl Chitosan/Sodium Alginate Microspheres as a Potential Drug Delivery System	
Abstract Objectives/Goals The objective is to find an appropriate delivery system to create oral protein therapeutics. Methods/Materials Carboxymethyl chitosan and sodium alginate were used to coat human serum albumin in the form of microspheres, which were treated in pH 2 and pH 7.5. A time course of the protein release from microspheres was studied by using UV spectroscopy and the structural integrity of the protein was assayed using HPLC. Results Microspheres treated in low pH were smaller than those treated in neutral pH. The protein concentration increased over time. In both low and neutral pH, microspheres showed a quick initial release, then an extended release, although those in low pH had a slower release rate. The HPLC showed that HSA was still detectable in low quantities. Conclusions/Discussion The release rate of the protein is related to the swelling degree of the microspheres. Those in low pH swelled less, resulting in slower release rates. The microspheres were able to maintain the structure of a portion of the protein. Therefore, carboxymethyl chitosan and sodium alginate is a viable potential oral peptide drug carrier.	
Summary Statement Carboxymethyl chitosan/sodium alginate microspheres can be used as a potential oral peptide drug carrier due to its extended release and its protection of protein integrity.	
Help Received I created the method for making microspheres from literature review. Dr. Tiansheng Li from HTL Biosolutions helped me learn to use the UV spectrophotometer and HPLC.	



CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s) Aditya Menon	Project Number S0622
Project Title Engineering Biologically Inspired Enzymatic Analogs: A New Class of Hybrid Organic/Inorganic Nanocatalysts	
Abstract Objectives/Goals The objective of this project is to develop more active and selective catalysts by integrating the inherent strengths of biological and synthetic catalyst characteristics while reducing their weaknesses. Methods/Materials To accomplish this, we developed methods to (1) synthesize and improve an organic support, (2) impregnate metal nanoparticles onto a microporous polymer organic framework support, (3) utilize spectroscopic methods to probe ligand removal and catalytic activity, and (4) overcoat the metal with an additional layer of the same organic framework to better replicate enzymatic machinery. Results The results show that a viable polymer organic framework with the critical features of thermal stability (up to 400 °C), high surface area (754 m ² /g), and microporosity (6 Å) was synthesized. Transmission electron microscopy was used to demonstrate that nanoparticles were evenly distributed onto the surface of the polymer with size 7.3 ± 1 nanometers. The optimal thermal pretreatment (300 °C for 20 minutes) was found to remove ligands, which block catalytic activity, from the surface of nanoparticles. Catalytic activity was measured using infrared spectroscopy, which revealed approximately 100% conversion of CO to CO(2) by 250 °C. This reveals that a fully functional hybrid organic/inorganic catalyst has been successfully developed. Finally, the catalyst was encapsulated by another layer of polymer. The encapsulated catalyst was able to maintain its structure, increase surface area (913 m ² /g), and regrow 6 Å micropores which were destroyed from the thermal pretreatment. The encapsulated catalyst showed increased efficiency in catalytic testing, reaching 100% conversion by 220 °C. Conclusions/Discussion Therefore, this project reveals the development of a functional, selective, and active hybrid organic/inorganic nanocatalyst which takes advantage of the inherent strengths of both biological and synthetic catalysts while reducing their weaknesses. It also presents a method to develop more active and selective materials by following the inspiration of enzymatic machineries with the potential to increase efficiency in important chemical reactions such as methane partial oxidation and carbon dioxide hydrogenation.	
Summary Statement I developed novel hybrid organic/inorganic catalysts by integrating the inherent strengths of both biological and synthetic catalysts while reducing their weaknesses.	
Help Received Andrew Riscoe, a PhD student, was my mentor for this project. He guided me through the initial methodology of this project. Dr. Matteo Cargnello provided overall guidance for the project. The facilities and instruments in the Department of Chemical Engineering at Stanford were used.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Camryn L. More	Project Number S0623
Project Title The Effects of Molecular Weight and Ion Size on the Refractive Properties of Dissolved Solids	
Abstract Objectives/Goals Objective: To determine if concentration, molecular weight, and ion size affect the refractive angle of visible light through solutions containing solutes of various sizes. It is not known if molecular weight and ion size affects the amount of light refraction. Methods/Materials Materials; light source, sodium chloride(NaCl), silver nitrate(AgNO ₃), sucrose, potassium iodide(KI), ovalbumin(OVA), polyethylene glycol(PEG), dH ₂ O, along with basic lab materials.Solutions were made using substances stated above. For each substance, three 10-fold dilutions were made starting with 10 Molar. This was performed for the solutions using four concentrations. Percent Brix was measured for each.Each concentration of each substance was examined three different times to get an average of each substance concentration. Results The results are depicted in Table 1 for all concentrations. At low concentrations, there was very small differences in light refraction between the various substances. Sucrose had the smallest amount of refraction at 2.33%, while OVA had the largest amount of refraction at 15.23% at a 1 molar concentration. Once a 1 M was reached, there were large differences in the amount of refraction between the substances with the largest molecular weights. Solutions with AgNO ₃ and KI refracted differently despite having similar molecular weights.There appears to be an inverse relationship between the ion size and the amount of light refraction. Conclusions/Discussion Many industries use refractometers to measure the concentration of certain substances in solution. The concentration of dissolved solids in solution is known to affect the amount of refraction. However, it was previously not known if molecular weight and ion size also affects the amount of light refraction. I demonstrated that with increasing molecular weight, light refraction increases, independent of concentration. In terms of ion size, it does not appear that larger ion sizes result in greater light refraction. Larger ion sizes (KI) resulted in a smaller of light refraction compared to smaller ion sizes (AgNO ₃), despite having nearly identical molecular weights. There appears to be an inverse relationship between ion size and the amount of light refraction, independent of molecular weight, so there must be another reason for this phenomenon. These findings may provide another use for refractometers, in terms of determining the purity of	
Summary Statement To determine if concentration, molecular weight, and ion size affect the refraction of visible light through various solutions.	
Help Received My father helped me by donating supplies, find background research, and also served as my mentor. A family friend, who has a phd in Chemistry, gave my inspiration for my research. My AP Chem teacher lent me equipment and her lab.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Jason B. Morris	Project Number S0624
Project Title The Effect of Electrolyte Solution and Concentration on the Production of Oxy-Hydrogen	
Abstract Objectives/Goals The purpose of this experiment is to determine which type and amount of electrolyte solution will produce the most oxyhydrogen in an electrochemical cell. Creating the gas will be done by electrolyzing water with an added electrolyte. Methods/Materials A oxyhydrogen electrochemical cell was constructed using various plumbing fittings, plexiglass and plastic tubing. 14 gauge stainless steel was cut to use as the electrodes and cathodes. The plates were sanded to increase surface area which in turn produces more oxyhydrogen. 1,532g of distilled water was used in the electrolyte solution because it contains very little impurities. Three different electrolytes were tested (sodium hydroxide, potassium carbonate, potassium hydroxide) at four different concentrations (5%, 10%, 15%, 20% by weight). The cell was powered with a 12 volt dc power supply. Production of gas was measured by timing how long it took to displace water in a one liter bottle. Results 15% Potassium Hydroxide is the best effective electrolyte at producing oxyhydrogen followed by Sodium Hydroxide and then Potassium Carbonate. Potassium hydroxide produced 62 ml/min of oxyhydrogen, 5 ml/min more than sodium hydroxide and 8 ml/min more than Potassium hydroxide. Strong electrolytes completely ionize in water. A strong electrolyte is either a strong acid or strong bases. Potassium Hydroxide and Sodium Hydroxide is a very strong base with a ph of 12. Potassium carbonate has a ph of 11. Once the concentration of the electrolyte by weight reached 20% the production of oxyhydrogen decreased to a lower production rate than the concentration of the 15% electrolyte solution. Conclusions/Discussion Oxyhydrogen is used in various applications such as oxy-gas torches as it burns at very high temperatures. Oxy gas torches are used for cutting and welding various materials including metal. Capturing the gases separately that are produced on the anode and cathode would results in very pure oxygen and hydrogen. Oxygen has applications in the medical field as well as recreational activities (scuba diving). It is also used in life support systems. In the industrial environment, oxygen is mostly used to refine iron ore into steel. Hydrogen can used to fuel hydrogen cars.	
Summary Statement Maximizing the generation of Oxy-hydrogen by determining the best electrolyte to use	
Help Received Craig Morris, my dad, helped with the cutting of the stainless steel plates	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Mihika Nadig; Andre Yin	Project Number S0625
Project Title Thermolytic Grafting to Stabilize Photonic Crystal Based Porous Silicon Sensors	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals My goal in this project was to stabilize porous silicon (pSi) in basic conditions (pH>7) using thermolytic grafting of trihydridosilane. Many drugs right now are taken orally, and they have to travel through the highly acidic stomach and then the much more basic small intestine to be absorbed in the body. Stabilization of pSi in acidic conditions has already been achieved, so stabilization in basic conditions will be useful for effective drug delivery in these fluctuating pH conditions and for detecting how much of a drug has been released with time.</p> <p>Methods/Materials The project started with the transformation of a silicon wafer to porous silicon through electrochemical etching. These porous silicon chips were then submersed in a solution to graft trihydridosilane onto their surface. The experiment consisted of four solutions, in which the pSi chips were immersed: two solutions with water (control), and two with pH 10 buffer. Three instruments were used for characterization of the modified pSi and measurement of stability over time: Fourier Transform Infrared Spectroscopy (FTIR), Spectroscopic Liquid Infiltration Method (SLIM), and Water Contact Angle Goniometry.</p> <p>Results The FTIR graphs portrayed that there was successful grafting of -CH groups onto the pSi, and that these groups remained throughout the experiment. The samples with grafting maintained porosity and thickness better than the control samples, as indicated by SLIM. In addition, Water Contact Angle depicted that the grafted samples were more hydrophobic than the control samples.</p> <p>Conclusions/Discussion FTIR, SLIM, and Water Contact Angle results provided sufficient evidence that the porous silicon was stabilized effectively in basic conditions. One major application of porous silicon is that it is a highly efficient and suitable drug delivery nanoplatform, given its large surface area and easily variable pore size. With its stabilization in basic conditions, pSi nanoparticles can deliver drugs to parts of the human body with basic pH, such as the small intestine. In addition, pSi can serve as a chemical sensor to detect undesirable gases in the air, such as hexane at gas stations. Because pSi has structural color, it can change colors with a change in refractive index, so it can also detect whether water has been drugged with alcohol.</p>	
Summary Statement I effectively stabilized porous silicon in basic conditions using thermolytic grafting of trihydridosilane, a result that has applications in drug delivery and chemical sensing.	
Help Received Professor Michael Sailor and Dr. Dokyoung Kim generously provided me with a lab space and answered my questions regarding porous silicon. Hannah Nakamoto etched the porous silicon. I handled all the other parts of my project by myself.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Andrea L. Noronha	Project Number S0626
Project Title Synthesis of Paramagnetic Iron Oxide Nanorods	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Currently, nanomaterials with high magnetophoretic velocity and magnetic susceptibility are needed for various applications such as drug delivery systems and bioseparations, but many paramagnetic nanomaterials cannot be easily controlled by an external magnetic field. Scientists are trying to synthesize anisotropic material that has superior magnetic properties due to the unique morphology. The goal of this project was to synthesize paramagnetic iron oxide nanorods with properties suitable for biomedical applications that can be easily controlled by an external magnetic field.</p> <p>Methods/Materials Iron oxide nanorods were synthesized using a modified sol gel method. Iron (III) chloride was hydrolyzed, and sodium sulfate was used to control the morphology. The nanorods were coated with polyacrylic acid so that they could be dispersed in water. A silica coating was done to reduce the aggregation between the nanorods. The sample was subjected to a forming gas reduction, and this sample was used to prepare a polymer thin film using polyethylene glycol diacrylate (PEGDA) as the polymer. The magnetic properties of the nanorods as a result of their shape anisotropy were demonstrated by exposing the thin film to a NdFeB magnet.</p> <p>Results TEM images taken at each step showed that the nanorods formed without much aggregation, and the PAA and silica coatings improved the particles' stability and dispersibility. Under the optical microscope, the nanorods were paramagnetic when exposed to an external magnetic field. The diameter of the silica coating is ~40 nm, and the length on the long axis of the nanorod is ~400 nm. The direction of the magnetic field could be easily controlled by an external magnetic field and fixed in the polymer with a thickness of 170µm by UV irradiation. When this polymer was exposed to an external magnetic field, the nanorods attempted to align the direction of their magnetic field with that of the magnet, resulting in bending of the polymer.</p> <p>Conclusions/Discussion Due to shape anisotropy, the nanorods have a high magnetophoretic velocity, as demonstrated by the polymer's response to an external magnetic field. Additionally, the dispersibility in water, low toxicity of iron oxide, and relatively low aggregation makes the nanorods suitable for various biomedical applications such as bioseparations, targeted drug delivery systems, and immunoassays where a strong magnetic attraction is advantageous.</p>	
Summary Statement A method to synthesize paramagnetic iron oxide nanorods was investigated with the purpose of easily controlling the nanorods by an external magnetic field due to the effects of the shape anisotropy.	
Help Received I used the lab equipment in the lab of Dr. Yin at the University of California Riverside under the supervision of Dr. Yadong Yin and Xiaojing Wang.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Phoenix T. Rumbaugh	Project Number S0627
Project Title Finding Material to Coat Clam Shells to Stop and/or Prevent Them from Dissolving in Acidic Liquids	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of the project is to find a material to coat short necked clam shells, so that the shells can last for short periods of time in acidic liquid.</p> <p>Methods/Materials 42 short necked clam shells about the same weight, 42 Ball jars. Scale, 3 acidic liquids: Seltzer Water, Coca Cola, Vinegar. 6 Coating materials: Bees wax, fluoride varnish, knox gelatin, kelp slime, casein, Agar agar mixed with glycerin. no coating 3 tests, 1st test of 12 coated clam shells placed in 14 jars filled with Seltzer Water at 4ph for 3 day 2nd test 12 coated clams shells placed in 14 jars filled with Coca Cola at 2.25 ph for 3 days 3rd test 12 coated clam shells placed in 14 jars filled with vinegar for 3 days</p> <p>Results The most effective clam shell coating with all three acidic liquids was Agar Agar mixed with glycerin. Agar Agar mixed with vegetable glycerin was 100 percent effective sitting in Seltzer water at 4 ph for 3 days. It was 100 percent effective in Coca Cola at 2.25 ph for 3 days. but it was 83-94 percent effect when placed in vinegar for 3 days.</p> <p>Conclusions/Discussion Repeated testing of the 6 clam shell coatings found the Agar Agar glycerin mix the most effect at protecting the short necked clam shells. Being a seaweed, the Agar agar and vegetable glycerin are nontoxic, biodegradable, durable, and flexible, which may make it a good candidate for use in the short term for protecting short necked clam shells. And it may possibly be used in the future on clam farms/</p>	
Summary Statement I created an Agar Agar/glycerin mix that may be used to coat short necked clams to protect them from ocean acidification.	
Help Received Information and help from Emily Green Chemistry teacher who taught me about fluorine and fluoride, Clifton Herrmann M. Sc candidate, applied marine and watershed CSU monterey bay, NOAA for their information about acidification, Bodega Bay Sea Lab, Bodega Bay Oyster Farm, Monterey Bay	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Richa Singh	Project Number S0628
Project Title Solving Flint's Lead Detection Problem: A Rapid, Low-Cost Test via a Chromophoric Reaction	
Abstract Objectives/Goals In 2014, Flint's water was contaminated with lead and other metals from their pipes. Residents in the area couldn't afford lead test kits since they are very expensive, so they didn't realize their water was contaminated until it was too late. This project solves this lead detection problem. A rapid and inexpensive (\$1) test for lead contamination in water was created so that everyone could easily test their water. Methods/Materials For this project, sodium rhodizonate, vinegar, and lead nitrate were primarily used. The sodium rhodizonate and vinegar were used to create a mixture so that when the mixture came in contact with lead in the water, it would change color. The lead nitrate was used as a safer substitute for pure lead hydroxide. The lead nitrate was only used to experiment whether the test worked. The vinegar was used to act as a catalyst for the chromophoric reaction to occur between the sodium rhodizonate and lead. Results When the 0.05M concentration of lead was tested, the test worked with 100% accuracy, and the color would change from orange to purple or dark red. When the 0.0001M concentration of lead was tested, the test worked with 82.5% accuracy, and the color would change to pink or red. When the tap water was tested, the test worked with 100% accuracy, and the color would either stay orange or turn yellow, indicating safe levels of lead in the tap water. Conclusions/Discussion The results show that this test is very consistent and reliable when being used to test for lead contamination in water samples. It is also very inexpensive, being only about \$1, and can be easily done by anyone who is worried about the quality of their tap water. This test can be used to prevent future incidences similar to Flint and allow everyone to be assured that their water is of pure quality.	
Summary Statement In this project, a test was created to easily, rapidly, and inexpensively test for lead contamination in water samples.	
Help Received My parents helped to obtain the materials for the experimentation, and Mrs. Gillum, my teacher, helped guide me through the science fair process.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Tamika C. Whitenack	Project Number S0629
Project Title The Effects of Fats on Quick Bread	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals I wanted to investigate the effects of saturated and unsaturated fats on the rheology, gluten development, and final structure of a quick bread.</p> <p>Methods/Materials I tested three different fat sources, each with differing amounts of saturated, monounsaturated, and polyunsaturated fat (coconut, canola, and walnut oil). I baked loaves of quick bread with each type of fat. I measured the rheology of the batter by measuring the flow rate of batter down an inclined sheet pan. I measured the final structure of the quick bread using a break-test method that I have seen used by America's Test Kitchen in which a slice of quick bread is balanced between two ramekins and must hold weight.</p> <p>Results I found that the batters made with the higher amount of saturated fat had a slower flow rate than the batters made with unsaturated fats. Likely due to a variety of errors, I did not obtain consistent results for the break-test. An extension experiment that improved the method for the break-test found that the quick bread made with the higher amount of saturated fat took longer to break than the quick breads made with unsaturated fats. These break-test results would suggest that saturated fat causes more gluten development and a less tender final structure in quick bread.</p> <p>Conclusions/Discussion The flow rates showed how saturated and unsaturated fats affect the rheology of the quick bread batters differently. This is likely a result of the different molecular structure (carbon single bonds vs carbon-carbon double bonds) that cause saturated fats to be solid at room temperature and unsaturated fats to be liquid at room temperature. Molecular differences could also affect the hygroscopic properties of the different fats, which would affect the final structure of the quick bread observed from the break-test. Hygroscopic molecules attract water and minimize gluten development, resulting in a tender quick bread.</p>	
Summary Statement My project explored how the molecular differences in saturated and unsaturated fats affected the rheology of quick bread batters and the final structure and gluten development of quick bread.	
Help Received One of my science teachers introduced me to rheology and shared past rheology experiments with me. My chemistry teacher discussed methods for performing measurements in my experiment. My mother helped me to collect the flow rates and break-times.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Alexander Woodside	Project Number S0630
Project Title Quenching Low Carbon Steel	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The goal of my project was to discover if it was possible to harden low carbon steel by exchanging the quenching medium.</p> <p>Methods/Materials In my project I tested four different quenching mediums to see if it was possible to harden low carbon steel. In order for a steel to harden, the steel needs to cool very quickly. Oil and water are traditional quenching mediums. When quenching in water, a steam envelope forms around the hot steel. My goal was to reduce the steam envelope so that the steel could cool faster. I chose salt water and a Deep Hardening Solution, which; reduces the steam to a nominal quantity. The steel was at the correct temperature to quench when it is no longer magnetic. After quenching, I tested how hard the steel became. I used a blacksmith technique called the file test. If the the file skates across the steel then the steel is hard enough for tool use. I will conduct ten trials per quenching mediums: vegetable oil, distilled water, salt water, and a Deep Hardening Solution.</p> <p>Results The basis of my hypothesis was salt would decrease the steam envelope. This was true, but did not affect the steel as I predicted. The decrease in the steam envelope impaired the water's ability to absorb heat. As a result the steel was not hardened. Steam was almost nonexistent when I quenched in the Deep Hardening Solution. It took a very long time for the steel to cool in the Deep Hardening Solution. When I quenched in the vegetable oil, all the signs of a successful quench were present. The oil absorbed the heat quickly and the steel cooled quickly. Unfortunately, the steel did not harden very well. It actually produced the softest steel of the experiment. In the end, distilled water produced the hardest steel sample.</p> <p>Conclusions/Discussion I must conclude that low carbon steel cannot be hardened by the methods I tested. Portions of some test samples were hardened because of the increased carbon content. My hardest sample (distilled water, trial 7) was not close to passing the file test. I have determined carbonized low carbon steel or mild steel are the best alternatives to high carbon steel. Mild steel has mid-range carbon content. It will produce a semi-hardened tool and would be much easier to carbonize. In the end, low carbon steel by itself is too difficult to harden.</p>	
Summary Statement This project provides data for steel manipulation by the quenching process.	
Help Received I would like to thank everyone around me for their constant support and advice. I thank my Mom, Dad, and Grandfather for all their help and advice.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Michael D. Wu	Project Number S0631
Project Title A Solar Powered Upconverting Nanoreactor for Highly Efficient Photochemical Synthesis	
Abstract Objectives/Goals Achieving solar powered photochemical synthesis has been the dream of chemists since Ciamician in 1912. Yet due to issues with current reactors and the inability of visible light to catalyze organic reactions, photochemistry has achieved limited applications in the real world. The two objectives of this project are to improve upon existing synthesis technology by harnessing TTA upconversion in a solar powered microfluidic nanoreactor and to synthesize ascaridole more efficiently. This project aims to increase the real-world applications of photochemistry. Methods/Materials The novel upconverting nanoreactor was fabricated and then used to synthesize ascaridole. Its efficiency and yields were compared to current synthesis techniques, batch and clear microfluidics, as controls. To fabricate the upconverting reactor, the Vaporization of a Sacrificial Component process was used to create a 35microliter channel embedded inside the polyurethane host. To harness upconversion processes inside the polymer, the uncured urethane was doped with PdOEP and DPA. Through triplet-triplet annihilation, these dyes will upconvert green to blue photons. Ascaridole was synthesized by flowing a solution of a-terpinene, Ru(bpy), methanol, and oxygen through the microchannel under 1.3 sun illumination. The product was collected, evaporated, run through a silica plug, and analyzed using absorption and NMR spectroscopy. Results Upconversion capabilities were successfully harnessed inside the polymer of a microfluidic nanoreactor, increasing the intensity of blue light inside the microchannel. The blue light emissions matched the excitation wavelengths of Ru(bpy) perfectly, more optimally sensitizing singlet oxygen and thus synthesizing more ascaridole. Once upconversion was added to the reactor, concentrations of ascaridole increased 86% when compared to current microfluidic technology, a significant improvement in yield. Conclusions/Discussion Harnessing upconversion in a nanoreactor is a significant improvement to existing organic synthesis techniques. When compared to batch reactors, it has higher efficiency and can be easier scaled up and when compared to microfluidics, it has significantly higher yields. Moreover, the upconverting microfluidic nanoreactor can synthesize other important medicines and fuel using only solar energy as its energy source with applications industrially, in rural hospitals, and developing nations.	
Summary Statement This project significantly improved current microfluidic technology by harnessing upconversion processes in the reactor, increasing yield and real world applicability of photochemistry.	
Help Received I did my research project in the Esser-Kahn Lab at the University of California, Irvine. Dr. Rachel Steinhardt from the group was an inspirational mentor, providing guidance and training along the way.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Erika Yang	Project Number S0632
Project Title Developing a Novel Flexible MoS2 Biosensor to Detect Lower-Concentrated Biomolecules at the Femtomolar Level	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The object of this study is to develop a novel flexible MoS2 biosensor to detect very lower-concentrated biomolecules.</p> <p>Methods/Materials I successfully fabricate a MoS2 biosensor on polyimide film, a flexible substrate which has great potential applications. The MoS2 biosensors can be used for rapid biomolecule quantification at fM-levels by analyzing the initial slopes of time-dependent response curves. The flexible MoS2 biosensors exhibited a detection limit for biomolecules as low as 50 fM that is about 10,000 times lower concentration than that can be detected by the conventional biosensor like ELISA.</p> <p>Results The fabricated MoS2 biosensors can be used for rapid biomolecule quantification at fM-levels by analyzing the initial slopes of time-dependent response curves. The multiple sensors can be utilized to enable quantification of low-abundance biomarker molecules as well as the affinities and kinetics of antibody-mediated binding events. The flexible MoS2 biosensors exhibited a detection limit as low as 50 fM that is about 10,000 times lower concentration than that can be detected by the conventional ELISA method.</p> <p>Conclusions/Discussion The MoS2 biosensors can be used for rapid biomolecule quantification at fM-levels by analyzing the initial slopes of time-dependent response curves. The multiple sensors can be utilized to enable quantification of low-abundance biomarker molecules as well as the affinities and kinetics of antibody-mediated binding events. The flexible MoS2 biosensors exhibited a detection limit as low as 50 fM that is about 10,000 times lower concentration than that can be detected by the conventional biosensor like ELISA.</p>	
Summary Statement I have successfully fabricated a flexible MoS2 biosensor that can detect biomolecules with a concentration as low as 50 fM that is about 10,000 times lower concentration than the conventional ELISA method.	
Help Received I have been working on this project for two years at a research laboratory. They trained me on equipment and I had some discussion with them.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Rohan Mehrotra	Project Number S0699
Project Title Novel Nanoscale Approach to Combat Disease: Electrically Stimulated Drug Release from Biodegradable PCL Nanofilms	
Abstract Objectives/Goals Today, drugs are administered orally or injected. Such methods distribute drugs systemically, resulting in low drug efficacy and side effects. To solve this, scientists have been developing stimuli-responsive nanocarriers that release drugs at targeted areas in response to external stimuli. An exciting research area is nanocarriers that release drug in response to electric stimuli. Current systems for electroresponsive drug release either use dangerous voltages (-5 to -15 V) or are non-biodegradable. My project goal was to develop a drug delivery system that is both biodegradable and uses safe voltages (-0.5 to -1 V) to trigger drug release. Methods/Materials I focused on a biodegradable, FDA-approved polymer called Polycaprolactone (PCL). I synthesized a nanofilm of PCL loaded with Fluorescein (FL), a model drug, then studied if the nanofilm had electroresponsive drug release capabilities. Results Drug release experiments demonstrated that the nanofilm had electroresponsive release capabilities. Voltages as low as -0.7 V resulted in greater FL release from the film compared to passive release. Drug release also increased in a linear, predictable fashion with increasing number of stimuli and increasing voltage. After the electroresponsiveness of the nanofilm was confirmed, I investigated the release mechanism. The electrode on which the film was formed increased in pH upon electric stimulation, and drug release increased in basic pH solutions. I hypothesize that the primary drug release mechanism is the accelerated hydrolysis of ester bonds in PCL catalyzed by the local pH increase due to electric stimulation. Conclusions/Discussion I envision my PCL nanofilm to be incorporated in a recently-developed ultrasonically-powered implant that can wirelessly stimulate electroresponsive drug release in the body. While this implant is not biodegradable, researchers have developed biodegradable electronics, which could be used to make the implant fully biodegradable. This drug delivery system would increase drug efficacy and enable more precise drug regimens (temporal/dosage control). It is convenient and safe, in part due to its biodegradability (ability to disintegrate in the body). This system could revolutionize the treatment of chronic diseases like cancer. To the best of my knowledge, this is the first demonstration of an electroresponsive drug delivery system that is sensitive to low voltages and biodegradable.	
Summary Statement I created a novel nanofilm composed of PCL loaded with a model drug. This is the first demonstration of a drug delivery system that is biodegradable and electroresponsive at low voltages.	
Help Received I would like to thank Devleena Samanta, Katy Margulis, and Professor Richard N. Zare at Stanford University for mentoring me throughout the project and providing me the opportunity to carry out my research in their lab.	