CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)

Wardah A. Bari

Project Number

S0601

Project Title

Investigation of Polydimethylsiloxane as a Solid Media for Fluorophores at Room Temperature

Abstract

Objectives/Goals

The goal of this project is to investigate the propensity of polydimethylsiloxane (PDMS) to absorb different fluorescent dyes, coumarin 151 (C-151) and N-phenyl-4-dimethylamino-1,8-naphthalimide (Ph-ANI). The doping of PDMS with dyes allowed us to study their photophysical properties in solid matrix at room temperature which is relevant for the design and engineering of polymer devices. We used ethanol and dichloromethane solutions of dyes to dope polymer and employed UV/Visible absorption spectroscopy, and steady-state and time-resolved emission spectroscopy for photophysical studies.

Methods/Materials

I fabricated the PDMS slabs by mixing PDMS prepolymer with curing agent (10:1), degassing the mixture under vacuum and pouring it into molds. Upon curing, PDMS turned into transparent elastic material. I removed PDMS slabs and blocks from the molds and cut into shapes required. Concurrently, I synthesized a nonpolar dye, N-Phenyl-4-dimethylamino-1, 8-naphthalimide (Ph-ANI) via a procedure developed in our lab. For comparative studies, I used commercial available dye, Coumarin 151. I made dye solutions with different concentrations in ethanol and dichloromethane (DCM). I soaked PDMS slabs in dye solutions. The solvents swelled PDMS, allowing the dye to diffuse into interior of polymer slabs. After washing and applying vacuum, the PDMS slabs returned to their original sizes and exhibited color and fluorescence inherent to the dye with which they were doped. I used absorption and emission spectroscopy to characterize the photophysical properties of PDMS-dye samples.

Results

The absorption and fluorescence spectra of dyes in PDMS were different from the spectra of the dyes in organic solvents. The absorbance revealed that DCM allowed for superior doping of the PDMS with both dyes. The fluorescence lifetimes of the dyes, obtained from single photon counting measurements, manifested small variations between the solvent and PDMS sample, indicating that the polymer environment did not dramatically perturb photophysical properties of fluorophores.

Conclusions/Discussion

We successfully demonstrated a facile method for doping PDMS with fluorescent agents. Spectroscopy studies confirmed the doping of the polymer and integrity of the dyes intercalated in the polymer environment. This method for introducing chromophores in optically transparent polymer materials will have important implications for photonics engineering.

Summary Statement

We demonstrated a facile and straightforward method for doping polymers with optically active agents, such as fluorescent dyes, and used UV/visible spectroscopy to confirm the feasibility of our approach.

Help Received

Dr. Val Vullev, Professor of Bioengineering and Duoduo Bao, Ph.D Candidate at UC Riverside supervised this project and helped me use the equipment supplied in the lab.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Alexander J. Brown

Project Number
S0602

Project Title
Playing CSI: The Effect of Exposure Time and Fuel Type on Fingerprints

Abstract

Objectives/Goals
I am doing this experiment because I am fascinated with the field of criminology, and if I could potentially help the field, I would be very eager to do so. There are two main factions of superglue fuming, one using sodium hydroxide, and the other using heat. Both methods create the same fumes from the glue that develops the fingerprint. I hoped to find if either worked faster than the other, and if one produced particularly better-looking prints than the other.

Methods/Materials
I will take 32 fired bullet shells and give them each my thumbprint. I will then test four of them per level of independent variable, (either the NaOH or lamp heat source, with either 2.5, 5, 7.5, or 10 minute exposures). This will be done inside a fish tank. Inside, I will place a small bowl of hot water as a humidifier, a quarter with glue on it, and either place the heat light nearby, or put flakes of NaOH on the quarter. After fuming, I will photograph and scan them onto my computer, take the images, enlarge them by an equal factor, and measure the ridges. Each print will be assigned a ranking of 0-4 on how clear the print is, the hope being to find an ideal ridge width for the clearest print possible.

Results
As the interval of time increased, the average width of each print ridge did increase, with the interval of ten minutes, (the longest), producing the best prints. In terms of qualitative measurements, visual clarity also noticeably improved as time went on. However, both ten minute sets exhibited the best prints as well as ruined prints that were overdeveloped. This shows that careful observation is required when fuming. In terms of the better fuel source, I observed no difference between the two methods, and the data supports this equivocal conclusion.

Conclusions/Discussion
My hypothesis about time affecting ridge width was correct; with light, the average width after 2.5 min was .30mm, whereas after 10 min, that average was .59mm. When using NaOH, the ridge measured .27mm after 2.5 minutes, and .58 after 10. Also, my hypothesis about more time making a better print was false, as after a 10 min exposure, some shells were well-developed, while others had been overexposed, and ruined by the long time.

My second hypothesis was disproved. I predicted that Sodium Hydroxide would have had a significant effect on how the prints turned out, but my results proved equivocal, with no clear victor in terms of results.

Summary Statement
I tested two variations of super glue fuming to assess their effects on the development of latent fingerprints.

Help Received
I received no help in making this project, besides my parents purchasing the poster materials...

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Alyssa L. Chan

Project Number
S0603

Project Title
Development of a Novel Optical Sensor for Simultaneous Detection of Total and Specific Volatile Organic Compounds

Abstract

Objectives/Goals
Volatile organic compounds (VOCs) represent significant health and environmental safety hazards. Sensors for VOCs exist, but are limited, due to cost and size constraints. We aimed to create a small and cost-effective, yet highly sensitive and selective sensor for VOCs.

Methods/Materials
Our sensor was fabricated by growing a thin-film, metal-organic framework (MOF) comprised of zeolitic imidazolate framework 8 (ZIF-8) on a porous silicon Fabry-Pérot layer. The MOF layer facilitated size-based discrimination between similar compounds, while also increasing sensitivity. Hexane and cyclohexane were used as model compounds, due to their similar molecular weights and chemical properties, but different shapes. Optical reflectance measurements involving analysis of Fabry-Pérot interference spectra were used to collect data.

Results
A ten-fold increase in sensitivity to hexane and significant ability to distinguish between the two vapors were demonstrated. Further, a novel way of analyzing the data allows for simultaneous quantitation of total VOCs and a specific VOC of interest from a single optical measurement, representing a significant improvement over current sensors. Preliminary studies show a 24% increase in sensitivity to natural gas, with this as yet unoptimized system. Thermal renewability, a new feature, increases the sensor's versatility.

Conclusions/Discussion
With these results, we have demonstrated the potential of this dual sensing system as a sensitive, selective, and renewable technology for VOC detection. This novel system has potential applications in a wide range of fields, including health and environmental safety and military and defense operations. Miniaturization and implantation of devices in fabrics allow for instant, on site sensing in settings, such as mines and combat areas. The large number of MOFs currently available allow for customization of this sensor to detect chemicals in virtually any size range.

Summary Statement
A novel sensor for simultaneous detection and quantitation of total and specific volatile organic compounds was developed using thin-film metal-organic framework layers on porous silicon photonic crystals.

Help Received
I would like to thank Professor Michael Sailor and Ms. Maggie Dudley for their mentorship and extraordinary guidance. I would also like to thank my parents for their unwavering support .

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Oliver Chen

Project Number
S0604

Project Title
Breakdown of CO(2) through Electrical Discharge

Abstract

Objectives/Goals
-To find out if it is possible to build a device to create carbon monoxide, for industrial use, from carbon dioxide.
-To find out what method is the best for completing this task.
-To determine the efficiency of that method.

Methods/Materials
Materials:Neon Sign Transformer 10 ft.of 600 volt stranded copper wire,2ft. of bare copper wire,20 ft.of # in.pvc pipe,6 # in.pvc elbows ,6 # in.pvc tees,5 gal.bucket,3 gallons of water,800g.of table salt,500 ft.of24 gauge enameled copper magnet wire, two 3 in.Nylon screws,6 nylon hex nuts,Tungsten spark gap, Carbon monoxide sensor, Oxygen sensor, CO2 tank,plastic container,Vinyl tubing
,1 in. copper tube,Large fan to keep the area ventilated.Procedure: 1.Turn on the fan to ventilate the area. 2.Fill the plastic container with the desired amount of CO2. 3.Measure the carbon monoxide levels inside and make sure they are zero. 4.Make sure there is a safe perimeter around the tesla coil. 5.Turn on the tesla coil for 60 seconds. 6.Record the carbon monoxide levels inside the container every 10 seconds.7.Repeat for every CO2 level test. 8. After the test leave the pump of the sensor on to clear all the gasses from the container and leave the area until all gasses are cleared.

Results
CO Production Rates:
1.9% Oxygen: -Total Average : 32.6 ppm per second
10.9% Oxygen: -Total Average: 13.8 ppm per second
20.9 % Oxygen: -Total Average: 6.4 ppm per second

Conclusions/Discussion
I concluded that it is possible to obtain CO and Oxygen for industrial use by breaking down CO2 through an electrical discharge. Through research I found that this CO could then be used for industrial purposes to make chemicals and fuel.And the oxygen,if captured,could be released back into the atmosphere to replace CO2.This, in turn can help slow down the effects of global warming and help improve our declining air quality. The next steps of my project will be achieving greater efficiency and sustainability by using a van de graaff generator instead of a Tesla coil.This will allow the device to be run off of renewable energy such as wind power.Also I hope to develop new materials to capture CO2 from the air and separate CO and Oxygen that are made in the breakdown process.By doing these things I hope to create a complete system for the capture and recycling of atmospheric CO2.

Summary Statement
The breakdown and recycling of atmospheric CO2 for usefull purposes through electrical discharge.

Help Received
Father helped obtain materials and supervised the experiment.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Adeline Chiang

Project Number
S0605

Project Title
The Effect of Temperature on Ascorbic Acid in Orange Juice

Abstract

Objectives/Goals
The objective was to determine if temperature affects the ascorbic concentration of orange juices, and if there is an effect, what temperature affects it most and least?

Methods/Materials
The types of orange juices used were 100% pure, natural orange juice, orange juice from concentrate, and fresh squeezed orange juice. The orange juices were all poured into flasks for preparation. Then, they were placed in different temperatures for 6 hours. I conducted my experiment at 3 and 6 hours by inserting 5mL of an iodine indicator solution into the test tubes. Then, I recorded the number of orange juice drops the indicator solution required to reach the equivalence point. The lower the number of juice drops, the more ascorbic acid present. The indicator solution is blue until equivalence point is reached turning it clear.
I also calculated the ascorbic concentration of the trials by figuring out the molar mass of ascorbic acid and the mol of iodine used in my indicator solution.

Results
My data showed that the heated orange juices needed the most drops to titrate and room temperature needs least. This means that the heated orange juices contained the least amount of ascorbic acid and room temperature contained the most amount of ascorbic acid instead of chilled as I predicted.

Conclusions/Discussion
My data shows that my hypothesis is correct. Heated orange juices do contain the least amount of ascorbic acid and chilled contain most. If I were to do this experiment again, I would test if air exposure does decrease the ascorbic concentration of orange juice and the effect of temperature on orange juice after a longer period of time. To keep the chilled orange juices in the same condition while I'm experimenting, I will put the flask of orange juice in cold water. To ensure accuracy, I hope I will be able to use micropipettes because they can accurately dispense the correct amount every time.

Summary Statement
My project is about how temperature affects the ascorbic content of the orange juice after being placed in a certain temperature for 6 hours.

Help Received
Chemistry teacher helped me understand the scientific terms and how to calculate the ascorbic concentration of the orange juices.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)

Forrest D. Csulak

Project Number

S0606

Project Title

Catalytic Conundrum: Comparing the Efficiencies of PEM Fuel Cells with Different Concentrations of Platinum Catalysts

Abstract

Objectives/Goals

The current situation facing the fuel cell economy is the cost of the platinum (Pt) catalyst required to make the cell work. My project was focused on determining whether fuel cells could be constructed with less Pt catalyst and still have a high enough efficiency to be cost effective. I hypothesized that there would be little statistical difference between the efficiencies of the concentrations of catalyst tested (0.1mg/cm^2, 0.3mg/cm^2).

Methods/Materials

My experiment was conducted with a PEM fuel cell attached via silica tubes to an electrolyser that converted distilled water into pure hydrogen and oxygen for fuel. The electrolyser was powered by a 6V lantern battery to keep a more consistent input power throughout the testing. Digital multimeters were attached to both the electrolyser and the fuel cell to measure input and output amps (I) and volts (V). These values were recorded every 30 sec. for 10 min. to rule out the effect on possible outliers in the data. I and V were multiplied together to find the input and output power (W). The output W was divided by the input W to evaluate efficiency. There were 10 trials for each test.

Results

The input power in trial 1 with the 0.1mg/cm^2 concentration of Pt was 2.68 W. It had an output power of 0.56 W and an efficiency of 20.99%. The input power in trial 1 with the 0.3mg/cm^2 concentration was 1.88 W, with an output power of about 0.70 W and an efficiency of 37.42%. By trial 10, the input power of the lower concentration was 1.17 W. The output power was 0.74 W and the efficiency was 63.78%. The input power of the higher concentration was 1.13 W, with an output power of 0.94 W and an efficiency of 83.34%.

Conclusions/Discussion

My hypothesis was proven to be incorrect. There was a statistical difference between the different concentrations of Pt catalyst used. I believe this is because the higher concentration of Pt created a higher surface area for the hydrogen atoms to partially bond with before losing their electrons to become positively charged ions. The efficiencies of each concentration consistently increased with each trial. I believe this is because the catalysts accumulated a higher concentration of hydrogen ions on their surfaces. This gradually overtook the impurities initially in the system. Further research into accurate costs for the catalysts and more statistical analysis needs to be done to draw more accurate conclusions.

Summary Statement

This experiment was conducted to see if the concentration of platinum catalyst in a proton exchange membrane fuel cell had a statistical effect on its efficiency.

Help Received

My mom purchased the supplies for experimentation. My grandma let me use her house to conduct the experiments and her computer to type my report.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Zoe E. Dubrow

Project Number
S0607

Project Title
Multi-Phase Droplets on Superhydrophobic Surfaces

Abstract

Objectives/Goals
The purpose of this project was to determine if liquids other then water could form droplets with contact angles above 150 degrees on a superhydrophobic surface. Once other liquids were discovered that had superhydrophobic properties to attempt to make multiphase droplets and characterize their properties, as well as to develop useful applications for multiphase liquid droplets on superhydrophobic surfaces.

Methods/Materials
The effect of surface tension on superhydrophobicity was determined and based on the criteria determined, certain liquids and solutions were screened on hydrophobically treated silica nano-particle based superhydrophobic surfaces. Methods were developed to combine these fluids into multiphase spherical droplets that could be physically and chemically manipulated by rolling them on a superhydrophobic surface. Durable superhydrophobic liquid marbles where a superhydrophobic membrane is suspended on the exterior of the droplet were also created both with a single liquid and as a multiphase marble.

Results
The high surface tension and polarity of water results in the formation of spherical (150° or higher contact angle) droplets on superhydrophobic surfaces. It was found that surface tension was the dominant property in determining if a liquid would form spherical drops. Glycerin and sorbitol solutions are two examples of such liquids. Liquids such as DMSO that had high polarities but only modest surface tensions wetted the superhydrophobic surface. Droplets on superhydrophobic surfaces and liquid marbles with multiple liquid phases have not been previously documented in the literature.

Conclusions/Discussion
A liquid droplet resting on the tips of the nano-particles of a superhydrophobic surface is essentially a container without walls. When multiple phases can be combined in a single drop new applications can be attempted. The utility of these multiphase droplets was shown in several experiments that made use of the rapid gas diffusion out of the drops as well as the concept of fluid mixing by rolling. A novel rapid bioassay is proposed for E. Coli detection utilizing the unique properties of multiphase liquid droplets.

Summary Statement
Surface tension was found to be the main factor that allows liquids to bead up on superhydrophobic surfaces, a finding which enabled the creation of novel multi-phase liquid drops and several potential applications.

Help Received
Dr. Hugh Daniels and Mr. Robert Dubrow gave valuable advice.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Samantha M. Guhan

Project Number
S0608

Project Title
A Unique Liquid CO(2) Based Green Extraction Process to Obtain Essential Oils from Spices

Abstract

Objectives/Goals
There is a great need to develop teaching labs that expose students to green chemical processing. The goal of this project is to develop a unique, convenient, visually dramatic process that employs the green solvent liquid CO2 to extract essential oils from spices. Students learn to draw on a wide variety of concepts such as phase diagrams, steam distillation, analytical techniques such as gas chromatography and mass spectroscopy, and chemistry of natural products.

Methods/Materials
The success of this design hinges on developing a system that safely builds and maintains pressure to maximize liquid phase CO2 and its contact with the spice. Therefore key parameters such as nature and size of extraction vessel, sample characteristics (size, texture and container), liquid CO2 availability, and bath temperature were optimized. Spices such as cloves, cumin, cinnamon, nutmeg and cardamom were extracted.The yield of essential oil was measured and composition determined using GC-MS. For cloves, the liquid CO2 method was compared with steam distillation in terms of yield, overall product distribution and quantitative assessment of the main component eugenol.

Results
The lab provides a real time visually dramatic evidence of phase change and extraction. The ideal extraction vessel that meets pressure requirements and safety criteria is a 15ml plastic centrifuge tube. Other optimal conditions include 1g sample of moderately ground spice in a sealed tea bag, dry ice (7g) filled to maximum capacity and a 38C water bath. The designed process successfully extracts essential oils from all spices tested. Yields are consistent with literature values and the key component of every essential oil is reproducible. In cloves, while steam distillation gave a higher yield, product distribution was superior in liquid CO2 extraction; twice the ratio of secondary products, caryophyllene and acetyl eugenol, to eugenol was obtained. A significant advantage of this process is the speed of extraction - about 15-20 minutes compared to 4 hours for steam distillation.

Conclusions/Discussion
The designed liquid CO2 extraction process works and is a great addition to a teaching lab curriculum based on green processing. Future experiments will focus on further optimizing the experimental set up, testing it in undergraduate labs to ensure reliability, and finding a way to measure the exact temperature and pressure in the extraction tube.

Summary Statement
A unique, visually dramatic, teaching lab on green processing that employs liquid CO2 to extract essential oils from spices was successfully designed and evaluated for its merits.

Help Received
Dr. Hampton was my advisor for this project - all experiments were done in his lab. Parents gave rides and edited report.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Irfan S. Habib

Project Number
S0609

Project Title
Investigation of Variations in Zinc Coating Thickness with Different Galvanized Metal Thicknesses

Abstract

Objectives/Goals
To investigate whether the thickness of zinc coating varies with thickness of different galvanized metal samples.

Methods/Materials
Eleven different galvanized metal samples of thicknesses varying between 1/4 inch to 26 gauge were obtained from B&B metal surplus.Each metal sample was 5cm by 5cm.First the mass of a metal sample was determined.Taking appropriate precautions a known volume of 6M HCL acid was used to immerse this metal sample in a 200ml beaker. Once the bubbling of the chemical reaction slowed significantly the metal sample was removed,rinsed with water,dried thoroughly,then reweighed.This procedure was repeated 4 times for each of the different metal thicknessess.

Results
Thickness of zinc was calculated using equation:t=difference in mass(zinc)/(density x area).Following results were obtained
1/4 inch t=0.011cm,3/16 inch t=0.008cm,10 gauge t=0.003cm,12 gauge t=0.005cm,14 gauge t=0.003cm,16 gauge t=0.003cm,18 gauge t=0.003cm,20 gauge t=0.003cm,22 gauge t=0.003cm,24 gauge t=0.003cm,26 gauge t=0.003cm
Number of zinc atoms were also calculated using the equation:
(2)t/(4.17 X 10(to the power of -10)
The 10,14,16,18,20,22,24,26 gauge samples all lost average of 1.439 x 10(to power of 7)atoms of zinc during the chemical reaction
1/4 inch lost 5.276 x 10 zinc atoms,3/16 lost 3.837 x 10 zinc atoms ,12 gauge lost 2.39 x 10 zinc atoms(all results to the power of 7)

Conclusions/Discussion
My hypothesis was accurate in that the zinc coating does vary with thickness of metal samples. During the corrosion,the solution bubbled vigorously indicating that hydrogen gas was released.Any errors may be due to removing the metal from the acid too quickly as this would mean that not all of the zinc had time to dissolve.However waiting too long could mean eventual corrosion of the steel.

Summary Statement
To find if there is variation of zinc coating thickness with different thicknesses of galvanized metals.

Help Received
B&B metal supply provided the galvanized metal samples.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)

Michael L. Janner

Project Number

S0610

Project Title

Synthesis and Manipulation of Silver and Gold Nano-Mirrors

Abstract

Objectives/Goals

Reflective nanoplates, or nano-mirrors, have shown to be good candidates for applications such as liquid mirrors in astronomical telescopes, but currently no reliable method of controlling these nanoplates exists. The objective of this experiment is to synthesize silver and gold nano-mirrors and manipulate their orientation using an external magnetic field.

Methods/Materials

Silver and gold nanoplates were synthesized in chemical reduction reactions using silver nitrate as a silver source and chloroauric acid as a gold source. The silver nanoplates were then put through a seeded growth process in order to increase their aspect ratio. The absorbance spectra of the nanoplates were measured and used as indicators of the architecture of the plates. In order to control the orientation of the nanoplates, they were injected into ferrofluid, a solution of iron oxide nanocrystals.

Results

Silver nanoplates were synthesized with spectral peaks ranging from below 400 nm (typically yellow in color) to over 1000 nm (light blue in color), signifying average edge lengths of 20-30 nm. The seeded growth process increased the edge lengths of the silver nanoplates to 2-3 µm while leaving the depth lengths, for the most part, unaffected. The gold nanoplates were synthesized with average edge lengths of 5-6 µm, which was large enough to manipulate without increasing the aspect ratio. Once the silver and gold nanoplates were introduced into ferrofluid, they acted as magnetic holes. This allowed their orientation in the solution to be controlled using an external magnetic field.

Conclusions/Discussion

Due to the large aspect ratio of the nanoplates, the base facets of the nanoplates reflected much more light than the depth facets, giving the nano-mirrors distinguishable "on" and "off" states. Therefore, once the orientation of the nanoplates could be manipulated using an external magnetic field, the nano-mirrors could be turned on and off by controlling which facet of the nanoplates was visible. The ability to control the nano-mirrors with an external magnetic field makes them very useful for applications in astronomical telescopes and adaptive optics.

Summary Statement

Silver and gold nano-mirrors were synthesized in chemical reduction reactions and an external magnetic field was used to control their orientation.

Help Received

Used lab equipment at the University of California at Riverside under the supervision of Dr. Yadong Yin and Qiao Zhang.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)

Grant King; Sarah Lamp; Matt Rhodes

Project Number

S0611

Project Title

Determining the Presence and Quantity of Caffeine in Coca Cola Beverages

Abstract

Objectives/Goals

This project tested the Coca-Cola product line in order to confirm the company#s claimed caffeine levels. Our null hypotheses held that the caffeine content in each of the five beverages was the same as that claimed by the Coca-Cola Company. Our alternative hypotheses held that the caffeine content for each beverage was different from what the company claimed.

Methods/Materials

We tested five major products (Coke Classic, Diet Coke, Cherry Coke, and Caffeine-Free Coke) to confirm their caffeine contents. The analysis was performed using High Performance Liquid Chromatography. We created a caffeine calibration curve by running a set of five known caffeine concentrations. We then tested our five products with a number of different samples, and ran each sample through the machine twice. We used methanol water as our control group to confirm the machine was running properly. After averaging our results, we compared them to the calibration curve in order to determine the caffeine levels in the various beverages.

Results

As expected, Caffeine-Free Coke and the methanol water were both free of any caffeine. Of all the tested beverages, Diet Coke had the most caffeine with approximately 46 mg per 12 ounces, while the other three were in the 33-34 mg per 12 ounces range. Both Diet Coke and Coke Zero had sample means similar to the Coca-Cola Company#s claimed caffeine levels. However, our sample Cherry Coke and Coke Classic displayed significantly lower caffeine levels than promised by the Coca-Cola Company.

Conclusions/Discussion

For Coke Zero, Diet Coke, and Caffeine-Free Coke, the company's claims were very similar to the means we obtained from the actual samples, suggesting that the named caffeine content is accurate for those Coca-Cola products. However, the data we obtained for Coke and Cherry Coke suggests that the caffeine content of at least some Coca-Cola products is not exactly what the company claims it to be. Coca-Cola making a cut in caffeine content like this would make sense, since a difference of just one milligram of caffeine per 12 ounces would save the company 14.6 million dollars over the course of a year.

Summary Statement

We tested Coca-Cola's claims for average caffeine content in five of its beverages using High Performance Liquid Chromatography.

Help Received

Dr. Malhotra provided us with the HPLC machine required for the project; Dr. Cauchon guided us through using the instrument for the first time and answered any questions we had about the experiment

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Valerie Lam; Lawrence Yu

Project Number
S0612

Project Title
Chemically Expediting the Degradation of Polylactic Acid

Abstract

Objectives/Goals
The objective of our science project was to see if acids and bases facilitate the hydrolysis of polylactic acid.

Methods/Materials
We chose to test the loud, but compostable three-layered Sun Chips bags, made of 100% polylactic acid (PLA). Using HCL, H2SO4, KOH, and NaOH in 1-molar and 5-molar concentrations, we soaked cutouts of the bag in beakers containing these strong acids and strong bases to facilitate and catalyze hydrolysis of the polylactic acid.

Results
The bags of the acidic solutions were compared those of the basic solutions to see how much degradation occurred. The basic solutions, after about 8 days, had dissolved the clear layer and the metallic layer of the bag and had fragmented the remaining layer. However, the acidic solutions had only dissolved the metallic layer and separated the clear layer from the bag.

Conclusions/Discussion
Through daily observations, we observed that the both kinds of solutions facilitate the hydrolysis of polylactic acid, but because of fragmentation, basic solutions facilitate hydrolysis more efficiently than the acidic ones. Next time, we can use different sources of PLA, particularly plastic ware, disposable cups, etc. In addition, by trying different concentrations of bases, we may be able to find one that is conducive to growing plants.

Summary Statement
Acidic and basic solutions chemically expedite the degradation of polylactic acid through hydrolysis.

Help Received
Used lap equipment at Flintridge Preparatory School under the supervision of Dr. Wahi

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Riana Lo Bu

Project Number
S0613

Project Title
Recapturing Carbon Dioxide: Maximizing the Methanol Alternative

Abstract

Objectives/Goals
The objective of this project: to determine which base is best in recapturing and recovering CO2 from the atmosphere,which is the first step toward maximizing the efficiency of this process.

Methods/Materials
Materials: weight measurement; 6 (250 mL.) flasks; 3 stoppers with 2 open holes; 3 stoppers with 1 open hole; 3 full stoppers; 3 hollow connecting tubes; 2 pounds of dry ice; potassium hydroxide (KOH) (10g.); calcium hydroxide (CaOH) (10g.); sodium hydroxide (NaOH) (10g.); water ; beaker; battery w/ cathode and anode wires; brownley apparatus; 2 large graduated cylinders; 2 washbasins; bucket of ice.
Methods: I capured carbon dioxide using strong bases and recovered the carbon dioxide using strong acid by performing a neutralization reaction. I used water displacement to determine amount of carbon dioxide produced.

Results
The results of the experiment were that barium hydroxide had the highest average percentage efficiency (1.55%), and KOH had the highest average recovery of carbon dioxide (0.0892 g.). KOH came in second with respect to average % efficiency (1.54%) and Calcium Hydroxide came in third with 0.692%. Barium hydroxide came in second with respect to average recovery of carbon dioxide with an average of 0.0481g., and calcium hydroxide was not only least efficient but also the worst recovery agent with an average of 0.0361g.

Conclusions/Discussion
The results of the experiment did not support my hypothesis because barium hydroxide ended up being the most efficient absorbent. But potassium hydroxide was stil the best recovery agent, and it was not far behind in efficiency. The extremely low percent yields and efficiencies were not expected. This was probably due to the fact that the scale of my experiment was too small. The low percent yields cannot rule out neutralization as an effective method of making methanol conversion a cyclical process because a signficant amount of carbon dioxide was being collected during the neutralization reaction.

Summary Statement
To determine which base is best for carbon sequestration and recovering of carbon after the sequestration process to be converted back into methanol.

Help Received
Dr.Wahi (high school chemistry teacher) provided lab materials

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)

Sofia Lochner; Caroline Vance

Project Number

S0614

Project Title

How Do Various Electrolytes, Polyatomic & Monatomic, Affect Charging/Discharging Efficiency of Algae Based Batteries?

Abstract

Objectives/Goals

The objective of our project is to compare two polyatomic and two monatomic electrolytes, in order to ascertain the most efficient algae based polymer battery. The monatomic electrolytes include sodium chloride and sodium iodide. The polyatomic electrolytes include sodium benzoate and sodium sulfite. Our hypothesis is: If monatomic and polyatomic electrolytes are used in an algae/Polypyrrole battery, then the charging/discharging efficiency of monatomic electrolytes will be superior.

Methods/Materials

After months of developing environmentally green battery electrodes, we were able to successfully construct functional batteries. The batteries were produced from the high specific-surface area cellulose, which was extracted from Cladophora algae. This high specific-surface area cellulose was utilized along with Polypyrrole, a conductive polymer, to create electrodes. When a layer of Polypyrrole was deposited onto Cladophora cellulose fibers with the help of iron chloride, the resultant was a mechanically stable and conductive paper sheet. Five different electrolytes were then tested with these electrodes to make batteries. These batteries were characterized using galvanostatic cycling, cyclic voltammetry, and open circuit voltage and current tests.

Results

The most efficient electrolyte, when used with Pyrrole and cellulose electrodes, was sodium benzoate. Sodium benzoate had the highest charge return of 76.4%, and the second highest open circuit voltage of 0.350 Volts. The second most efficient electrolyte was sodium sulfite with a charge return of 13.3%. The open circuit voltage for sodium sulfite was by far the best with a 1.15 V average. Both of these electrolytes have polyatomic anions.

Conclusions/Discussion

In conclusion, from the data collected from this experiment polyatomic electrolytes are more efficient than monatomic electrolytes in algae based polymer batteries. Our data contrasts our original hypothesis that monatomic electrolytes would increase the charging and discharging efficiency of these batteries. In general, it appears that after multiple charge and discharge cycles, the anions intercalated more readily into the polymer. The algae-based composite material shows promise in ion-exchange capacity and cycling stability when used as a working electrode in an electrolytic solution.

Summary Statement

How do various electrolytes, polyatomic and monatomic, affect charging and discharging efficiency of algae based polymer batteries?

Help Received

We used lab equipment at University of California Santa Barbara under the supervision of the graduate student, Alan Derk.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Hanni J.M. Newland

Project Number
S0615

Project Title
The Effect of Various Light Sources on the Rate of an Iodine to Iodide Photochemical Reaction

Abstract

Objectives/Goals
My goal was to determine the effect of various light sources on the rate of and Iodine to Iodide photochemical reaction.

Methods/Materials
Reference solutions were made with iodine and distilled water with varying iodine concentrations (100%,50.0%,25.0%,12.5%,6.25%,3.13%,0.00%) These were used to compare test samples to when data was collected. Three ammonium oxalate solutions were made and iodine was added. Each solution was poured into their respective centrifuge tubes and placed in front of the designated light sources. Each light source had 4.5mL of each solution placed 10cm away and observations of the % concentration of iodine left in each tube were made in comparison to the reference solutions every 15min. for 2hrs.

Goggles, Gloves, Face masks, Masking tape, Permanent pen, Metric rulers, Digital scale, Cups, Centrifuge tubes, Test tube rack, Beaker, Graduated cylinders, Beral pipettes, Distilled water, Timer, Plastic spoon, Aluminum foil, Ammonia, Oxalic acid, Tincture of iodine, Light sources-LED, Fluorescent, Incandescent, Shop light w/clamp, Extension cord.

Results
The most important finding was that after 15min. all solution samples placed in front light had reacted more than the reference solutions which were in the dark. Out of all the light sources the solutions exposed to incandescent light had reacted the fastest. All solutions in front of incandescent light had fully reacted by 60 min. All three of the samples from each of the light sources and the reference solutions all had 0 dev, except for the solutions exposed to the incandescent light. Which had at 30 min. mean 8.11%, avg. dev. 4.60, % deviation 56.69%. After 45 min. mean 3.00%, avg. dev. 1.33, % dev. 44.44%. At 60 min. mean 0.67%, avg. dev. 0.22, % dev. was 33.33%.

Conclusions/Discussion
The hypothesis that incandescent light would speed up the rate of the reaction the most was supported by the data. It was inferred that the incandescent light (57w) accelerated the reaction the most because its intensity/heat. Out of all the light sources the solutions exposed to incandescent light had reacted the fastest. All solutions in front of incandescent light had fully reacted by 60 min. It was inferred that the solutions in front of the incandescent light may have reacted the fastest due to the heat of the light source. The heat may have given more energy to fuel the reaction than the lower temperature LED and fluorescent sources.

Summary Statement
The purpose of my experiment was to determine the effect of various light sources on the rate of and Iodine to Iodide photochemical reaction.

Help Received
My father and mother helped in the gathering of materials, and made sure that the area used during research and experimentation was free of any hazards or any safety risks.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
David L. Polyakov

Project Number
S0616

Project Title
Up In Smoke: The Effects of Additives on the Fire Resistance of Paint, Year 2

Abstract

Objectives/Goals
Determining whether the addition of readily-available, low-cost substances, when mixed with exterior or interior house paint, improves the fire resistance of the paint through the release of carbon dioxide, which reduces oxygen, and/or through an endothermic reaction, which reduces heat, two of the three necessary components of fire?

Methods/Materials
Pine wood cut into equal 30 cm, by 10 cm, by 2 cm pieces, stop watch, propane torch, propane gas, fire extinguisher, sodium carbonate, sodium bicarbonate, calcium carbonate, potassium bicarbonate, Glidden brand interior paint, Speedcoat brand exterior paint, paint roller, power drill, whisk, infrared thermometer, camera, video camera, plastic cups, and homemade burning assembly.

Results
With additives, interior paint was more fire resistant than the exterior paint, and potassium bicarbonate additive provided the greatest fire resistance when mixed at 5% with the interior paint. The mixture of interior paint with single additive 2% sodium bicarbonate provided the most fire resistance. Combination additives of potassium bicarbonate and sodium carbonate provided the greatest fire resistance and lowest average temperature when mixed with interior paint. Interior paint with 5 percent additives produced the lowest average temperatures.

Conclusions/Discussion
By adding a small amount of common chemicals to paint, one can enhance its fire resistance. The endothermic reaction occurring when the torch flame strikes the painted wood results in less heat being emitted, thus eliminating a necessary component of fire. When heated, the additives in the paint also release carbon dioxide which displaces oxygen, another necessary component of fire. Mixing two additives with the paint enhanced the fire resistance. In addition to the type of additive, the percentage of additive to the paint was telling, since too much of an additive caused the paint to separate from the wood during the trials. With no paint and additive to absorb the heat and release carbon dioxide, the wood was less fire resistant.

Summary Statement
Testing whether the addition of low-cost, readily available substances to interior and exterior paint improve its fire resistance.

Help Received
Father helped buy supplies, build structure, light torch, and video record experiment.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Adam J. Protter

Project Number
S0617

Project Title
Rapid Colorimetric Melamine Detection via Gold and Silver Nanoparticles

Abstract

Objectives/Goals
Melamine is a nitrogen rich organic base chemical used in wood, plastics, and adhesives that has recently been in the center of a food adulteration scandal in Asia. Recent scientific papers have concluded that gold nanoparticles can be used to detect melamine. The purpose of this project is to determine if silver nanoparticles, alone or in combination with gold nanoparticles can detect melamine in a colorimetric assay.

Methods/Materials
The aggregation and absorption properties of silver nanoparticles, as well as a gold/silver nanoparticle mixture were tested and compared with a published method of melamine detection utilizing unmodified gold nanoparticles. In order to test the effectiveness of the nanoparticles, varying sizes of nanoparticles were mixed with melamine, and any color changes observed visually, and quantitatively using spectrometry. Cyanuric acid, which complexes with melamine to form a precipitate, provided further visual confirmation of the presence of melamine.

Results
10nm silver nanoparticles consistently indicated the presence of melamine, yet were slower to aggregate than gold nanoparticles. Gold nanoparticles proved inconsistent in certain trials. The 20-50 nm silver nanoparticles did not aggregate in the presence of melamine.

Conclusions/Discussion
Unmodified 10nm silver nanoparticles, as well as a mixture of 10nm silver and 10nm gold nanoparticles are effective in detecting melamine in a colorimetric assay. My research concurred with a previously published paper, with 10 nm gold immediately indicating a color change, showing the presence of melamine. However, in my research, I found that gold nanoparticles were inconsistent. In several trials, the unmodified gold nanoparticles did not aggregate. The 10 nm silver nanoparticles were reliable and consistent, although they took a longer time to aggregate, approximately 30 minutes. The mixtures of gold and silver nanoparticles were effective in detecting melamine, and produced consistent qualitative data. The results were rapid, within 6 minutes, and there were no trials in which they failed to aggregate. However, the mixture provided very inconsistent quantitative data. The 20-50 nm silver nanoparticles did not yield any positive results for melamine.

Summary Statement
I created a novel method of detecting melamine in a colorimetric assay using silver nanoparticles.

Help Received
Used lab equipment at UCLA under the supervision of Dr. Fang Wei. Additional guidance provided by Dr. Malhotra, Thousand Oaks High, Science Advisor.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Sulekha S. Ramayya

Project Number
S0618

Project Title
Increasing the Efficiency of Energy Extraction from Landfill Gas

Abstract

Objectives/Goals
The overall objective of this project was to prove the commercial viability of utilizing landfill gas (LFG) to produce renewable energy. Two additional steps, carbon sequestration and the Sabatier reaction, not usually implemented during the processing of LFG, were considered to calculate whether they would increase the total energy extraction from LFG. Another objective was to see if complete carbon dioxide (CO(2)) conversion to methane (CH(4)) could actually be attained.

Methods/Materials
In the laboratory hydrogen (H(2)) and CO(2) from gas tanks were reacted to create CH(4) through the Sabatier reaction. The reaction took place in a reaction chamber filled with catalytic ruthenium covered alumina pellets and zirconium ceramic fibers 450^oC. In the experiment, flow rates of H(2) and CO(2) were measured using flow gauges, and the CH(4) produced was detected using a Non-dispersive Infrared Detector and current produced was measured using a voltmeter.

Results
The detector and voltmeter were calibrated to read 4 mA when there was no methane to 25 mA when the methane concentration was 100%. To arrive at the optimum process parameters, conversion tests were performed at multiple flow rates at constant temperature. Complete conversion of CO(2) to CH(4) occurred at the flow rate of CO(2) at 12 scfh and H(2) at 5 scfh. Using these measurements and the two additional steps, calculations were done to see what the net increase in energy produced would be.

Conclusions/Discussion
This novel way of converting CO(2), from carbon sequeatration of LFG, to CH(4) creates the possibility of providing purified CH(4) to gas turbines to generate electricity. This process increases the net efficiency of the LFG power generation by 250% as the energy density of CH(4) is 980 BTU/SCF compared to the energy density of LFG 480 BTU/SCF. The combustion of CH(4) in LFG reduces the effective GHG emissions, while implementation of the Sabatier reaction increases the total energy output of LFG.

Summary Statement
The project tested if 100% conversion of CO(2) into CH(4) was feasible and calculated the net increase in energy produced from LFG by implementing the additional steps of carbon sequestration and Sabatier reaction.

Help Received
Used lab equipment at Stapelton Tech. Lab under the supervision of Dr. Rangappan; Minimal assitance in setting up equipment (e.g. lifting gas tanks); Had calculations verified by Dr. Rangappan

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Christopher L. Sercel

Project Number
S0619

Project Title
How to Make Your Household Carbon Arc Run Longer

Abstract

Objectives/Goals
My objective is to determine the relative effect of oxidation on the electrode corrosion in a carbon arc.

Methods/Materials
Two 50 ohm space heaters were wired in parallel to use as a resistor. Three types of tests were used: helium (to eliminate oxygen), standard atmosphere, and pumping fresh air through the arc. A T-shaped quartz tube was used to flow gas through the arc, with the rods coming in two ends and gas through the third. The run time of the arc was measured as a measure of corrosion. The more corrosion, the wider the gap between the rods, so it terminates automatically eventually.

Results
The tests with fresh air pumped in lasted the shortest, with tests about 20 seconds, standard atmosphere was in the middle with tests about 45 seconds, and helium lasted the longest with tests around 400 seconds and one test at 665 seconds.

Conclusions/Discussion
This demonstrates that oxygen has a large effect on the corrosion of a carbon arc. In addition, the sound of the tests with oxygen was greater than the helium tests, and the corrosion is different visually.

Summary Statement
Determining the effect of oxidation on the corrosion of a carbon arc.

Help Received
Mother helped proofread report; Father helped by offering advice and ordering the quartz.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Stephanie M. Vistnes

Project Number
S0620

Project Title
The Effects of Steric Hindrance on Non-SN2 Reactions

Abstract

Objectives/Goals
While researching the theory and mechanics of steric hindrance, I noticed that every example and description I saw for steric hindrance had to do with SN2 reactions. This led me to wonder: Does steric hindrance have an effect on non-SN2 reactions? I hypothesized that yes, it does.

Methods/Materials
I would have loved to have used a lab and done extensive experiments to test my hypothesis, but with very limited resources available to me, I decided to use an online chemical database instead. Using this database and an online 3D molecule viewer, I searched through nearly 15,000 compounds and found 3 molecules that contained an inaccessible atom which was not a part of a polyatomic ion, and that had reactions listed for the compound. For each of the three compounds, I also found 2-4 similar compounds: compounds with the same core group of atoms, including the inaccessible atom, but with a different group of atoms bonded to the core. I also found at least one or more positive examples (controls): compounds with a base very similar to the original compound, but in which the inaccessible atom was exposed. For each category of compound, I found multiple reactions involving the compound.

Results
In each compound, I found that in the positive example (control), the compound was involved in multiple reactions, SN2 and otherwise, in which the atom of interest took part in the reaction. In my compounds with inaccessible atoms, on the other hand, the inaccessible atoms did not take part in any reactions.

Conclusions/Discussion
From my results, I was able to conclude that my hypothesis was correct and that steric hindrance does have an effect on non-SN2 reactions. Although this does not prove the theory of steric hindrance, I do believe that I have gone one step further by providing evidence in support of the steric hindrance theory.

Summary Statement
I explored the effects of steric hindrance on non-SN2 reactions by finding sterically hindered compounds and examining the reactions in which they were involved, and concluded that steric hindrance does have an effect on non-SN2 reactions.

Help Received
Father introduced the topic, and pointed me at the online databases.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)

William T. Winick

Project Number

S0621

Project Title

The Dance of the Calcium Cage

Abstract

Objectives/Goals

This aim of this project is to discover why EGTA-decalcified gastrolith solutions produce Nuclear Magnetic Resonance spectra with twice the number of expected peaks. My initial hypothesis was that EGTA, in the presence of calcium, is in chemical exchange between two different populations with chemically distinct environments

Methods/Materials

NMR Spectrometers: I used three different NMR spectrometers: Bruker DPX-200, AV-III 400, and AV-III 600. Between these three instruments, over 54 spectra were recorded, creating a large database from which to find patterns, assign the 1H and 13C spectra, and monitor the suspected dynamic equilibrium of EGTA-Ca++ binding and release over a variety of temperatures and concentrations. Samples: At the start of the project, four D2O solutions of different Ca:EGTA N,N,N′,N′-tetraacetic acid) ratios (0:1. 0.5:1, 1:1, and 2:1) were prepared by Ms. Anat Akiva. DSS (2,2-Dimethyl-2-silapentane-5-sulfonic acid) was subsequently added to the samples as a reference (δDSS = 0 ppm) to calibrate the chemical shifts (x-axis) of the NMR spectra.

Results

With a Ca:EGTA ratio of 0.5:1, I observe a combination of the two EGTA spectral populations previously observed ("free" and "bound"). The peak assignments for the 0.5:1 Ca;EGTA spectrum are shown as a combination of the 0:1 and the 1:1 ratio spectra. Next, several experiments were conducted on the 0.5:1 Ca:EGTA sample under various temperatures (304K, 320K, 330K, 336K, 340K, and 343K) in the 200MHz spectrometer. If the free and bound states are in dynamic equilibrium, by heating the solution, I expected to observe the classic textbook behavior of the bound and free resonance frequencies experienced by the same proton as it broadens and merges on the NMR timescale. The peaks on the spectra did merge together, revealing a dynamic equilibrium between the free and bound states.

Conclusions/Discussion

EGTA, in the presence of calcium, has been proven to exist in a dynamic equilibrium between free and caged states. When there is a non-stoichiometric ratio of EGTA to calcium, there is a combination of spectra from the free and caged states, representing a slow dance of the calcium cage. Also, the peak pairs merge as the temperature increases, indicating that the EGTA cage has begun a faster dance on the NMR timescale. Now that this has been settled, gastroliths can be sampled again, so bone regrowth research can be continued.

Summary Statement

Discovering the chemical exchange between calcium and EGTA so bone regrowth can be achieved.

Help Received

Used lab equipment and received all materials from Dr. Yael Balazs at the Technion University in Haifa, Israel.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Katherine J. Woolard

Project Number
S0622

Project Title
The Effect of Different Base Oils and Biodiesel to Diesel Blends on RPM and Consumption Time in a Model Airplane Engine

Abstract

Objectives/Goals
The purpose of this project was to find out if biodiesel was a reasonable alternative to diesel in model airplanes and, if so, which base oil type with which blend of biodiesel and diesel would be the best in terms of RPM and fuel consumption time.

Methods/Materials
I used three different batches of home-made biodiesel each with a different oil base (peanut oil, corn oil, and safflower oil). I tested the biodiesel by combining the different biodiesels with the proper amount of diesel to attain three different percentages of biodiesel to diesel (10% biodiesel to 90% diesel, 30% to 70%, and 50% to 50%) resulting in nine different testing groups. I then injected each sample one at a time into a diesel model airplane engine that was securely attached to a table, running a shot of pure diesel between each test to eliminate contamination. Using a stopwatch and an RPM measurer, I collected the data and recorded it in the laboratory notebook.

Results
The peanut biodiesel in a 10% blend showed to have the highest RPM out of all the different biodiesel blends. The safflower biodiesel in a 50% blend resulted in the longest fuel consumption for the three blends. It was shown that all the 10% blends when compared to the 50% blends had the highest RPM while the 50% blends all had the longest fuel consumption time. When an ANOVA was run, all the results were shown to be statistically significant.

Conclusions/Discussion
Biodiesel is a longer chain molecule than diesel, meaning that a higher compression ratio in the engine would be required to burn it. This would account for the fact that the 50% blends took longer to burn than the 10% blends because of the higher concentration of larger chain molecules. Also, each base oil had a different make-up of fatty acids (capric, lauric, myristic, palmitic, stearic, oleic, linoleic, and alpha linoleic) with a different number of carbon molecules and carbon double bonds on the molecular chain. When analyzed for the different amounts of heat energy that are released, it was shown that the heat outputs by the different oils were remarkably similar with a maximum difference of 4.4 kcal.

Summary Statement
This project was designed to test the effectiveness of different base oils in biodiesel and blends containing biodiesel and diesel in various amounts on the RPM and fuel consumption time in a model airplane engine.

Help Received
Father oversaw lab work and oversaw conduction of experiment

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Laura H. Yu

Project Number
S0623

Project Title
If I Dye What Madders?

Abstract

Objectives/Goals
To achieve the brightest red dye out of fresh madder root. If the older (larger) roots are grinded, then the color of the dye extract will be deeper in color than using the young roots.
If the inner part/core of the roots is used after the grinding, then the color of the yarns will be redder than the outer part.
If the experimenter dyes the cotton, then the color of the dyed material will be more vibrant red than the nylon or wool.

Methods/Materials
What was used to conduct the preparation of the dye baths and the dyeing of the fibers were freshly ground madder root, distilled water, a thermometer or temperature probe in degrees Celsius, the SpectroVis and Vernier Lab Quest interface device as well as basic lab equipment. To make a dye bath one mixes the root and water, heats, filters, and then measures the absorbance levels in cuvettes with the Spectrometer; the process of dyeing is to make a dye bath with the concentration of 17.5 g to 300 mL of distilled water with samples 4A, 4B, and 4C. Soak, heat, filter, and heat it again then place the pre-soaked fibers into the samples.

Results
The results are not quantitative but rather qualitative data, based on subjective identification of color. Therefore the experimenter#s findings might differ from those of another person. None the less the experiment found that the core of the larger root and the wool a protein fiber produced the most vibrant red dye.

Conclusions/Discussion
In conclusion the brightest dye can be achieve when making an extract from the largest roots because they have the most surface area, the core of the roots since that is where most of the red dyeing chemical alizarin is, and using the wool which is the protein fiber. These findings will allow more people to understand the intermolecular forces between the dye material and the fibers.

Summary Statement
Various sizes and parts of the madder root as well as the type of fiber being dyed affects the brightness of the red color produced.

Help Received
Mrs. Carlberg lent the great madder and dyeing books; she also provided guidance and the madder plant was from her garden. Mrs. Wagner allowed me to use the chemistry lab and the Vernier lab equipment. Kim Nguyen told me what the graph of the Spectrometer should ideally look like.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
Chen (Amy) Zhang

Project Number
S0624

Project Title
How Strong Is the Molecular Force in a Drop of Liquid?

Abstract

Objectives/Goals
I mainly want to find out the strength of intermolecular forces in a drop of water and other liquids, look for a simple way to observe and estimate those intermolecular forces, and see what factors could affect the force strength in a drop of liquid molecules.

Methods/Materials
Samples of liquids include water, ethanol, red wine, red tea, NaCl/water, and sugar/water. The method in the following I called block-separation method:
1. Make two copper cylindrical blocks with the same diameter
2. Hang the top block on a block holder with the flat surface facing down
3. Put a drop of water on the flat surface of the bottom block
4. Align the bottom block to the top one, with the drop of water in between
5. Stick the two blocks together vertically. They will attach to each other
6. Put a small weight on the string that is fastened tightly to bottom block.
7. Add more weights until the bottom block separates from the top block
8. Record the total weight that caused the separation
9. Repeat the same procedures (steps 2-8) with different liquids

Results
The intermolecular forces in drops of liquids were measured by using the block-separation method. The strength of intermolecular force between two water molecules was around 2.5E-16 Newton. The intermolecular forces of ethanol solution in various concentrations diluted with pure water were also measured. When those samples of liquids were compared, the results are that the sugar solution has the strongest intermolecular forces, and ethanol has the weakest intermolecular forces.

Conclusions/Discussion
My experiments demonstrate that the intermolecular forces of liquids are quantitatively measureable by using the block-separation method. The intermolecular forces of water molecules are around 2.5E-16 Newton per molecule in force. The measurement results also reveal that the intermolecular forces do not totally depend on the size or complexity of the liquid molecules. They seem to be more influenced by polar strength of liquid molecules. That does make sense since the intermolecular forces are actually electrostatic forces between positive and negative electric charges.

Summary Statement
I want to find out a simple way to measure the strength of intermolecular forces in a drop of liquid.

Help Received
My dad helped to make the metal blocks; my mom helped to record data while I was conducting the experiment. Both of them helped me with building the board.

CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)

Jiahong Zhang

Project Number

S0625

Project Title

Application of Micro and Nano Sized Magnetic Beads for the Purification of Water

Abstract

Objectives/Goals

The preparation of low cost, non-toxic chitosan coated magnetic nanoparticles and their application for heavy metal ion removal from water are the main goals. The nanoparticles are made to have fast adsorption and slow settling rate while keeping fast magnetic separation from water.

Methods/Materials

The raw magnetic nanoparticles were prepared via glycothermal synthesis. The magnetic nanoparticles were coated with SiO2 and then covalently coated with chitosan via a cross-linker. A dynamic light scattering instrument determined the size distribution of the beads. The Zincon colorimetric reagent determined the presence of trace amounts of metal ions. Each metal ion (Cu2+, Hg2+, Zn2+) complex with Zincon were first characterized through their absorption spectra. The concentrations of the metal ions in water before and after beads treatment were determined based on their absorption v. concentration graphs. A kinetics procedure determined the adsorption capacity of the beads.

Results

Nanoparticles had slow magnetic sedimentation, resulting in decreased separation efficiency. The estimated optimal bead size range is 500-1000nm. Beads with size ~800 nm had fast adsorption (<1min for 0.5 mM Cu^2+, Hg^2+, Zn^2+, slow sedimentation rate (>60 min), and fast magnetic separation (<1 min for 1cm x 1 cm x 1cm volume solution). Magnetic beads adsorption capacity ~30-40 mM heavy metal ion per gram of dry weight beads.

Conclusions/Discussion

There is a size limitation for chitosan coated magnetic nanoparticles. Small size such as 150 nm leads to slow magnetic sedimentation rate. Large particles such as 1.5 um resulted in fast natural sedimentation rate, which decreased the efficacy in heavy ion adsorption. An optimal range of about 500 nm-1000 nm is best for this application. The trace amounts of heavy metals such as Cu^2+, Hg^2+, and Zn^2+ can be spectrometrically determined via Zincon as a colorimetric reagent.

Summary Statement

The removal of heavy metal ions, such as mercury, from water by using chitosan coated magnetic micro and nano particles.

Help Received

This project was done with Dr. Luo at the UC Davis School of Medicine Cancer Center during summer 2010.