## Materials Science (1400)

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The rationale of this experiment is to determine whether carbon nanotubes can be used to strengthen concrete. Stronger concrete could be used to prevent building collapses, like the one in Surfside, Florida. Building collapses are a common disaster in the world. A study by Wardhana et. al (2017) found a total of 225 building failures between 1989 and 2000, costing millions of dollars and thousands of lives. Studies have found their properties to be applicable across many areas of science. The phenomena being investigated is the extraordinary properties of carbon nanotubes such as their strength, elasticity and heat resistance. By using carbon nanotubes to strengthen concrete structures, future building collapses caused by weak concrete can hopefully be prevented. Due to its electron configuration, carbon can easily form covalent bonds with other elements. This provides carbon the ability to create many different molecules. Even more so unique is carbon's ability to bond to itself in different ways, enabling the formation of carbon nanotubes. The structure of carbon nanotubes is a thin layer of hexagons wrapped into a tube shape and believed to be what enhances their tensile strength. Carbon nanotubes are not only extremely strong, but also flexible. The strength and flexibility of carbon nanotubes, combined with their low thermal expansion coefficient could be the perfect additive to enhance concrete strength. Concrete is usually reinforced by rebar which is prone to rusting and requires expensive repairs or replacement. If a structure is replaced, the new structure’s concrete will likely be reinforced with rebar and require further attention in the future. Repair or replacement are costly options that continue to require maintenance. Through this experiment, it was found that carbon nanotubes used as a reinforcement additive does enhance concrete strength. The increased strength

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# The Effect of Layering Plastics and UV Light on Luminosity

Chandini Arun, Ramya Chaganti

The bionic eye is a unique upbringing in technology that enhances vision for the blind. One specific device focuses on the correlation between the bionic eye using cross-modal mapping, which is the perception that involves interactions between two or more different sensory modalities (Farvardin, Mohsen, et al., 2019). The device is called Argus 11. This device is implanted in your eye and employs light cues that allow the patients to see the images focused and fast. The light passes through the glasses lens and transmits to the video processor and the battery. This then wirelessly transmits to the eye, which enables vision. The process of cross-modal mapping helps Argus 11 link wirelessly with the battery using signals. The glasses used in this experiment are made of plastic.

This experiment will focus on the specific glasses and lens types used in Argus 11. This experiment aims to test two different types of plastics and see which has the highest observance with light. This experiment uses polyethylene terephthalate plastic sheets and Polycarbonate plastic sheets. The new implantation in this experiment employs layering of the plastics against luminosity. A projector light (acting as the video processor) will shine through the plastic sheets. This experiment requires the use of a flashlight. In a previous experiment, flashlight light was used to shine through the different types of plastic and see if the light could go through materials, contributing to this experiment. (What can light move through? 1999). We are implementing different colors of light that will be used to shine through the polyethylene terephthalate sheets and Polycarbonate plastic sheets to observe if different wavelengths can affect the lens clarity. This experiment will help Argus 11 by improving the lens clarity as much as possible to benefit visually impaired people.


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**Effects of different mixture ratios on starch-free shear thickening fluids**

Chris Duong

My experiments explore the properties of shear thickening fluids and what causes them to occur. My project involves testing different mixture ratios of alternative shear thickening fluid ingredients to see which mixture ratios create shear thickening properties or the strongest shear thickening properties. In the experiment, I tested 3 types of mixtures, a polyethylene based mixture, a Fumed silica mixture, and a mixture of both. To create these mixtures, I first added a constant base of 20 mL of water and then added increased amounts of either polyethylene glycol, Fumed Silica, and more. I then tested each mixture’s viscosity, ability to absorb impacts, color, and strength of shear thickening. From the experiment, I learned that the particle is the most crucial part in creating shear thickening properties. A particle’s shape, strength, and size affects their ability to shear thicken. Particles that are rough edged, collapsable, and small work the best to compact in a liquid during an impact, supporting why starch creates such a strong shear thickening property.


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Supporting the Weak Points on a Triangular Structure

Cassini Rajesh

Current research has proved that triangular structures are generally the strongest shape. This research experiment dives into how triangular structures can be supported even further. The materials involved in the experiment include a wood cutter, gorilla glue, balsa wood sticks, and weight plates. Essentially, in order to experiment on how to support triangular structures even further the procedure involves two balsa wood structures where one of the structures has additional support structures, and the other structure has no additional support structures. The balsa wood structures will be created by making precise cuts with the wood cutter, which will be connected using the gorilla glue. Once both structures are created, weights will be put onto both structures to record how much weight each structure held and the difference between the weight in both structures. Finally, calculations will be done to figure out how the structure with additional support structures was able to hold the additional weight. The research experiment is still in progress, so conclusions cannot be drawn yet.


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Development of a 3D Printed Acoustic Tile to Determine an Inexpensive Method of Soundproofing
Sahlar Salehi

Soundproofing, or the act of making a space resistant to sound, is crucial to meet the acoustic demands of audio recording. Current acoustic foam tiles used to soundproof rooms cost around $12 per square foot, which is expensive for most content creators. Inexpensive alternatives lack the soundproofing capabilities of acoustic foam tiles. Without effective soundproofing, content will have lower audio quality, which could lead to reduced profits for creators.

To combat this issue, an acoustic tile was designed and 3D printed to reduce manufacturing costs while maintaining acoustic effectiveness to provide an alternative soundproofing material for content creators. An acoustic tile was designed in CAD and 3D printed in thermoplastic polyurethane (TPU 95A), which has elastic properties necessary for acoustics. The novel acoustic tile was tested in its ability to reduce the loudness of sound passing through the material, and compared to other soundproofing materials. Multiple frequencies of sound were played from inside a testing box with and without acoustic materials, and a sound meter was used to record the loudness of sound passing through each material. The difference in decibels of sound between the box with and without soundproofing was calculated to determine the reduction in the loudness of sound. The 3D printed tile’s sound reduction ranged from 0.85 to 2.5 dB, which was more or less effective than other materials at variance. The preliminary results indicate that 3D printing could be a viable alternative for producing effective acoustic materials, while at the very least reducing costs.


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The Effect of Sugar Concentration on the Durability of Single Use SCOBY Plastic Alternatives

Sophie Thomas, Jade Visser

300 million tonnes of plastic are produced yearly with more than 90% exploiting unsustainable resources like petroleum, coal, and natural gases. This project used SCOBY, an organic cellulose material, to create a biodegradable high density plastic alternative. SCOBY, or Symbiotic Culture of Bacteria and Yeast, is a byproduct of kombucha, a fermented tea, containing Bacillus coagulans bacteria and Saccharomyces cerevisiae yeast. A mixture of black tea, starter kombucha, SCOBY with live cultures, and various sugar concentrations (6.3%, 7.2%, 8.2%) were grown in growth chambers at 26°C and a humidity of 34% with no light. Under a level 2 biosafety cabinet, new SCOBY growth derived from starter SCOBYs were separated and placed in individual containers for a continued growth period of two weeks. Once SCOBY thickness was a minimum of .5 cm, they were dried for 5 days. Ultimate tensile strength, elongation, and moisture durability (for biodegradability), and microscope pictures (before and after degradation) of the SCOBYs were measured and analyzed. Preliminary data suggests groups grown in higher sugar concentrations stretch more before a full break, but not necessarily withstand the highest force (N). SCOBY may be useful in production of single-use plastic objects like plant pots, reducing the amount of plastic waste around the world and reliance on unsustainable resources. Research on the effect of SCOBY on soils and its biodegradability suggests SCOBY plant pots are promising alternatives to plastic as they add phosphorus, decrease soil pH, and have the ability to replace commercial fertilizers.


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Artificial turf fields have been used in professional and recreational athletics since the 1970's, with the first successful implementation of AstroTurf in the Houston Astrodome in 1966. These fields are composed of two parts, the infill or “dirt” of the field and plastic blades of grass. The most commonly used infill is known as crumb rubber, which is normally old shredded rubber tires. When artificial fields are experiencing warm conditions a heat sink is created, the plastic grass absorbs the UV rays, bringing into the ground, and heating up the rubber and surrounding area of the field dramatically. This can cause players difficulty breathing, nausea, heat stroke, and in extreme cases burns.

In order to create a less heat retentive field, testing of infills of varying color and material type was conducted. Cork, as well as normal crumb rubber and no infill as controls trials. Data was collected by measuring the initial temperature at 5 different areas of the field at 15 minute intervals over the course of an hour.

Current data of three tests confirms that crumb rubber increases temperatures, and cork does not yield any significant changes, future testing will be conducted on colored rubber turf in five variants (red, blue, white, green, and yellow) and vermiculite to determine the best option for turf infill replacement.


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The Effects of Different Washing Methods on Face Mask Protection Efficiency
Lula Xanthakys

The COVID-19 pandemic began in twenty-twenty, spreading rapidly around the globe causing chaos, death, and disruption. In order to help protect oneself from contracting the virus, scientists have determined that wearing face masks was one type of effective intervention for minimizing transmissibility. This has resulted in face masks becoming the new norm. As a result of ongoing studies, the Center for Disease Control (CDC) has released information and data to support which types of masks offer the best protection against the coronavirus. However, it’s still unknown if there is a best practice or method for washing reusable masks that will allow for them to remain effective over a longer period of time.

This study analyzes and determines the best way to wash cloth face masks to allow for maximum longevity and effectiveness. This will be completed in both a laboratory setting and within a home environment. There will be two different washing methods; hand-washing and machine washing. After the masks are washed, they will be secured, using safety pins, to a piece of litmus paper containing a matching number. After each paper is fastened and sprayed, they will sit for forty-five seconds. At that point, they will be tested by the penetrability of the droplets and measured through color change on the piece of litmus paper. Currently, preliminary data collection is in progress. And based on basic observations it can be seen that vinegar can penetrate more significantly through the masks that were machine-washed vs the masks that were hand-washed.