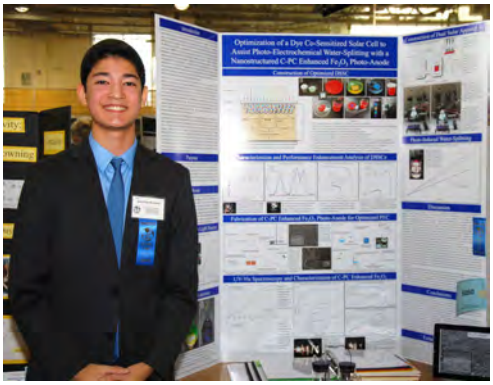
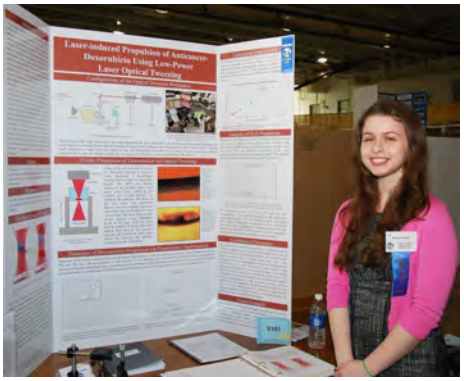
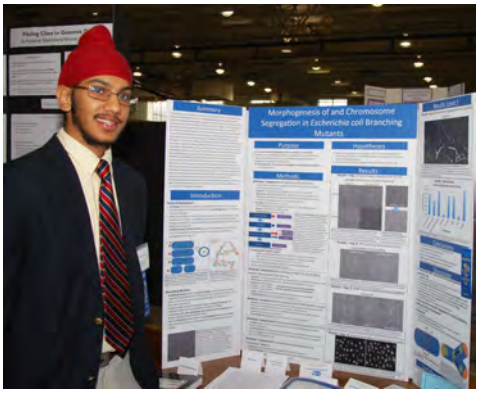
CONNECTICUT SCIENCE & ENGINEERING FAIR
at the
INTEL INTERNATIONAL SCIENCE & ENGINEERING FAIR
Phoenix, Arizona, May 12 - 17, 2013
Meet the Winners



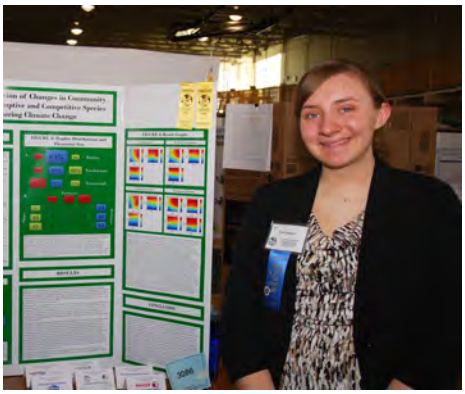
Maxmillian Minichetti, Greenwich HS
1st Place, Dominion Physical Sciences



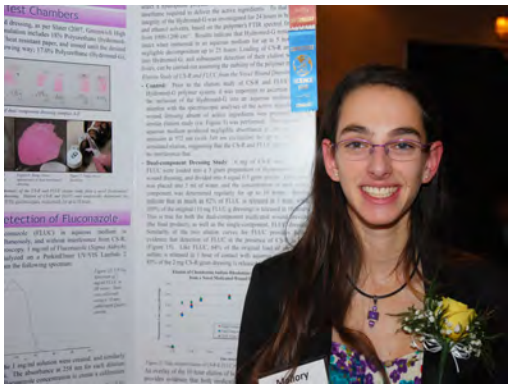
Rebecca Murray, Greenwich, HS
2nd Place Dominion Physical Sciences



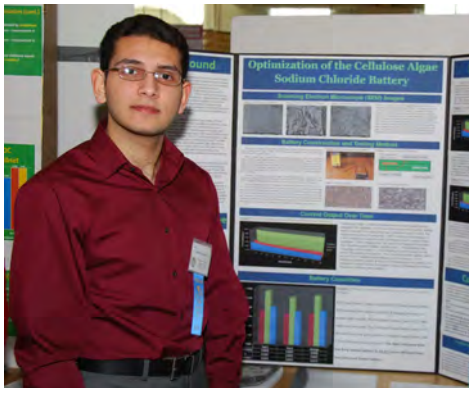
Kaitavjeet Chowdhary, Glastonbury, HS
1st Place, Pfizer Life Sciences



Emily Baczyk, Choat Rosemary Hall
2nd Place, Pfizer Life Sciences



Mallory Madfes, Greenwich HS
1st Place, Alexion Biotechnology



Karim Kharbouch, Bridgeport Aquaculture
1st Place, Urban School Challenge

CONNECTICUT SCIENCE & ENGINEERING FAIR

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Trip Winner to the
Intel International Science and Engineering Fair
May 12 - 17, 2013, Phoenix, AZ

(Student information as of April 2013)

Maxmillian Minichetti, Grade 10

Greenwich High School, Greenwich, CT

Project Title: Optimization of a Dye Co-Sensitized Solar Cell to Assist Photo-Electrochemical Water-Splitting with a Nanostructured C-PC Enhanced Fe_2O_3 Photo-Anode

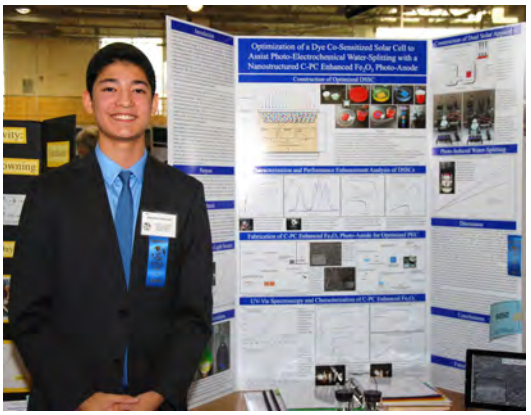
Connecticut Science & Engineering Fair Awards

- Dominion Millstone Power Station Physical Sciences Awards --- 1st Place - Physical Sciences Senior High Individual - $500 & trophy, trip to compete at Intel ISEF
- UTC Aerospace Systems Awards for Excellence in Engineering --- $1,000 cash and plaque for excellence in engineering
- H. Joseph Gerber Medal of Excellence, an award of the Connecticut Academy of Science and Engineering in partnership with CCAT --- Physical Sciences Senior - $1,000 cash, Solid Silver Medal of Excellence, invite to CASE Annual Mtg
- Arthur Mensing Award --- $500 cash award for excellence in the physical sciences

Abstract

Scientists have expressed significant interest in Dye Sensitized Solar Cells (DSSCs) as an easily manufactured, inexpensive means of generating clean energy. An equally substantial interest for clean energy storage has also emerged, which can be achieved with photo-electrochemical water-splitting via Photo-Electrochemical Cells (PECs). This study seeks to optimize and investigate the performance of a TiO2-based DSSC, enhanced by the dye co-sensitization of Nile Red (NR), Nile Blue A (NB), Rhodamine 110 (R110) and Anthocyanin (A) dyes, for the purpose of assisting an Optimized PEC that uses a C-Phycocyanin (C-PC algae extract) enhanced Fe2O3 photo-anode. This project culminates in the construction of a Novel Dual Solar Apparatus which can be practically applied for electricity generation and/or the storage of this energy by photo-induced water-splitting. Dye co-sensitization significantly augmented the DSSC's spectral response to UV-Vis wavelengths of incident light. The Optimized DSSC achieved a 3% solar conversion efficiency allowing for a 59% increase in output voltage and a 129% increase in output current in comparison to a conventional Anthocyanin DSSC. The efficiency of an Fe2O3 photo-anode was substantially enhanced by employing the C-PC light-trapping nanostructures by covalent cross-coupling (CCC) which allowed for a 13.4% increase in PEC performance, a photo-anodic voltage increase of 127%, and a photo-current improvement of 66%. Finally, the Novel Optimized Dual Solar Apparatus was able to generate hydrogen gas at a rate 57% greater than that of a Dual Solar Apparatus without a photovoltaic metal oxide anode. With additional research and innovation, the Dual Solar Apparatus can be augmented for modern-day application alongside current hydrogen fuel cells.

Biography



I am the first born child to an architect father and a homemaker mother, and I have two younger sisters, ages twelve and seven. As a toddler my favorite place to be was the American Museum of Natural History and the Metropolitan Museum of Art. These places were a haven of inspiration for my affinity to learn and discover, of which I would recreate and translate through my legos, playmobiles, and other building toys. I also loved the Dorling Kindersley ***Eyewitness Series*** about various topics, from art and science to evolution and ancient civilizations. I began to discover a broader, more universal connection within these subjects upon entering elementary school in Greenwich, CT. Despite my parents' claims to great anxiety over my academic performance, being the last kid in kindergarten to be able to count to one hundred, and the last kid to learn how to read in first grade, the scientific and innovative content of these museums and books actually nurtured a strong foundation of knowledge for me. They enriched my passion for discovery. In middle school, I was introduced to the topic of alternative energy. Since then, I have been intrigued with various means of harnessing solar power. As a sophomore at Greenwich HS, I am able to conduct and pursue my own research endeavors in a more ambitious and meaningful attempt to satiate my hunger to bring about innovation to the scientific and modern-day world.

CONNECTICUT SCIENCE & ENGINEERING FAIR

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Trip Winner to the
Intel International Science and Engineering Fair
May 12 - 17, 2013, Phoenix, AZ

(Student information as of April 2013)

Rebecca Murray, Grade 11

Greenwich High School, Greenwich, CT

Project Title: Laser-Induced Propulsion of Anticancer-Doxorubicin Using Low-Power Laser Optical Tweezing

Connecticut Science & Engineering Fair Awards

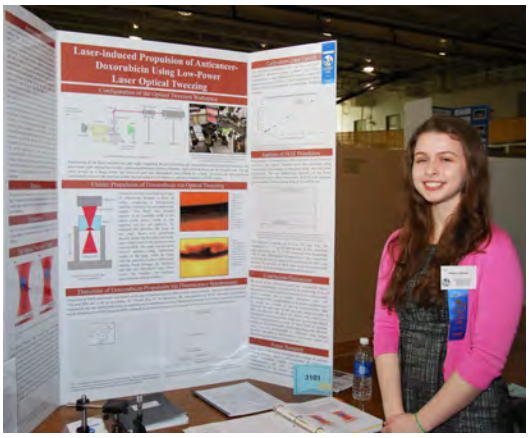
- Dominion Millstone Power Station Physical Sciences Awards --- 2nd Place- Physical Sciences Senior High Individual - $300 & trophy, trip to compete at Intel ISEF
- Coherent, Inc. Richard Hart Award for Excellence in Photonics --- $300 cash, plaque, invitation to lunch and tour Coherent factory

Abstract

The laser induced movement of molecules across a liquid-liquid interface has significant potential in changing the way medications are introduced to cells, as it causes minimal damage to the surrounding cells and doesn't require mechanical intervention. Previous methods of laser transport have required high-powered lasers and relatively durable drug molecules for transportation. This research investigates induced movement of a chemotherapy drug through the use of optical tweezers, which is created by focusing the beam of a laser to a point that can be used to trap particles. This effect can be used to move complex drug molecules across an interface without harming the molecules, and only utilizes an 8 mW He-Ne laser. Experimentation involved successfully transporting particles of the cancer drug Doxorubicin across a membrane between two immiscible liquids, from a liquid in which it is not soluble (water) into a liquid in which it is soluble (chloroform). Transportation was achieved using a simplified optical tweezers configuration, including a lower-powered laser relative to traditional setups. In 250 µl of water, 73 ng of solid Doxorubicin were transported into 550 µl of a neighboring chloroform layer, corresponding to the transport of 7.3 x 10^{16} molecules with a single illumination. Movement and subsequent presence of the Doxorubicin in the chloroform layer was confirmed using the drug's natural fluorescent properties, with detection based on 550 and 590 nm emissions with an excitation wavelength of 230 nm. Practical application would use this method to transport miniscule amounts of drug molecules across a cell membrane.

Biography

Rebecca Murray is a junior at Greenwich High School enrolled in the Honors Science Research program. This is her first year competing at the Connecticut Science and Engineering Fair. Her research focused on using laser light to deliver small amounts of anti-cancer medication to cells. Rebecca was successful in finding a way to use a low-power laser to move drug molecules across a model cell membrane. Rebecca is a member of her school's varsity debate team and state-winning math team, and is President of the Chinese National Honors Society chapter at GHS. She is currently looking into colleges and plans to major in engineering.



CONNECTICUT SCIENCE & ENGINEERING FAIR

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Trip Winner to the
Intel International Science and Engineering Fair
May 12 - 17, 2013, Phoenix, AZ

(Student information as of April 2013)

Kaitavjeet Chowdhary, Grade 12

Glastonbury High School, Glastonbury, CT

Project Title: Morphogenesis of and Chromosome Segregation in Escherichia coli Branching Mutants

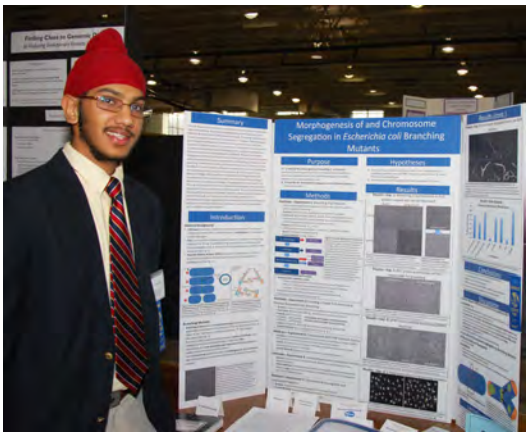
Connecticut Science & Engineering Fair Awards

- Pfizer Life Sciences Awards --- 1st Place- Life Sciences Senior High- $500 & trophy, Trip to compete at Intel ISEF
- H. Joseph Gerber Medal of Excellence, an award of the Connecticut Academy of Science and Engineering in partnership with CCAT --- Life Sciences Senior - $1,000 cash, Solid Silver Medal of Excellence, invite to CASE Annual Mtg
- Biophysical Society --- Biophysics Award- $100
- University of New Haven 11-12th Grade Awards in Engineering & Science --- $100 for Top 11th or 12th Grade Project in Microbiology

Abstract

The cell shape of any bacterium is essential to its function. Recent studies have shown that deletion of a group of peptidoglycan-synthetic enzymes called Penicillin Binding Proteins (PBPs) leads to a unique, *branching* morphology in *E. coli*, causing rod shaped cells to bifurcate into "Y"-shapes. The mechanisms governing the morphogenesis of these mutants, especially the role of the essential cell division protein, FtsZ, are not well understood. This study aimed to probe the morphogenesis of branching mutants, and also investigate how the process of chromosome segregation is affected. Through site-directed mutagenesis of 90 FtsZ surface amino acid residues, we isolated the 96th amino acid as the single FtsZ residue responsible for cell branching. Comparisons with branching in PBP deletion strains, and immunofluorescence microscopy of FtsZ and MreB in the FtsZ mutants, allowed us to propose a novel model pointing to the morphology being a result of the interaction of this residue with Low-Molecular-Weight PBPs to position the cytokinetic FtsZ Ring. Additionally, visualization of chromosome localization in the branching mutants through DAPI staining revealed an even pattern of segregation into both branch arms. Thus, we also proposed a model for chromosome segregation in these mutants. Ongoing and future experiments will involve mutant "rescue" experiments and more specific chromosome localization methods. Understanding the questions posed in this study and future work will provide key insight into the fundamental processes responsible for how bacterial cells control cell shape, as well as into chromosomal dynamics. Such work is promising for applications such as antibiotic drug development.

Biography



Kaitavjeet Chowdhary is a senior at Glastonbury High School. This year, he conducted research on the molecular mechanisms controlling cell shape in bacteria. In this work, he studied mutant *E. coli* cells to develop a general model identifying a link between proteins known as Penicillin-Binding-Proteins with a protein called FtsZ in correctly positioning the bacterial division site and in controlling aspects of cell shape. He also studied patterns of chromosome localization in these mutants. Applications of such research potentially include identification of novel drug targets and development of new antibiotics. In addition to winning 1st place in Life Sciences at this year's CT Science and Engineering Fair, Kaitavjeet won 1st place at the CT Junior Science and Humanities Symposium, and was a Semifinalist in both the Siemens and Intel Science Talent Search competitions. In school, Kaitavjeet serves as President of the Model UN club and Captain of the Debate Team, as well as competes on his school's 1st place winning science bowl team. An avid musician, Kaitavjeet plays euphonium in his school band and has played at the regional, All-State, and All-National levels. Kaitavjeet aspires to eventually earn a combined MD-PhD degree and become a physician-scientist. He will attend Harvard University in the fall, where he plans on studying molecular and cellular biology.

CONNECTICUT SCIENCE & ENGINEERING FAIR

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Trip Winner to the
Intel International Science and Engineering Fair
May 12 - 17, 2013, Phoenix, AZ

(Student information as of April 2013)

Emily Baczyk, Grade 12

Choate Rosemary Hall, Wallingford, CT

Project Title: A Model-Based Approach to Predicting Species' Responses to Climate Change by Characterizing Community Dynamics

Connecticut Science & Engineering Fair Awards

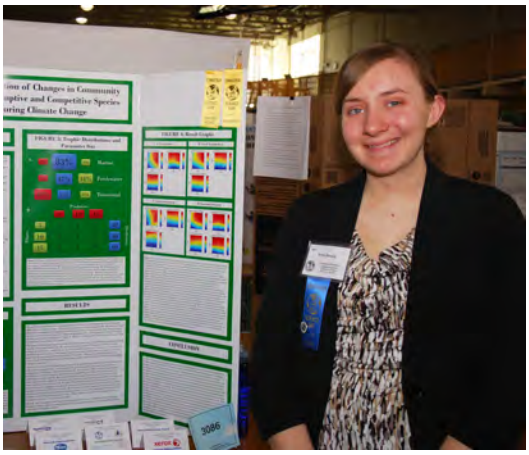
- Pfizer Life Sciences Awards --- 2nd Place- Life Sciences Senior High- $300 & trophy, Trip to compete at Intel ISEF
- People's United Bank Mathematics Awards - with ATOMIC --- High School Finalist - Medallion & Acrylic Award
- Xerox Computer Science Awards --- 1st Place High School - $400, Trophy, Medallion
- Intel Excellence in Computer Science Award --- $200 & certificate
- Long Island Sound Foundation, Inc. --- $500 Life Science/Environmental Science/Physical science
- Yale Peabody Museum --- Family "six-pack" of free passes to the Yale Peabody Museum
- Milton Fisher Science Fair Award for Innovation and Creativity --- For Excellence in Creativity and Innovation by a High School student, $200 cash
- Otero Family Award --- The Otero Family Award; $200 cash

Abstract

My goal was to determine how a climate change-induced temperature increase of 4 ˚C over the next 100 years would affect the composition of ecological communities occurring along an elevational or latitudinal temperature gradient, with the goal of determining what conservation strategies may be most effective. Towards this end, I developed a novel computer-based model of a general community with three different trophic levels, representing the basal (e.g., plants), intermediate (e.g., herbivores), and top (e.g., predators) species typical of a food web. Consumptive and competitive interactions between these species were approximated with discretized difference equations. I incorporated temperature-dependence for many species- and trophic-level parameters, including conversion efficiency, handling time, and reproductive fitness. I used empirical data to inform parameter values and established theoretical models to define the relationships between species and with their environment. Various model formulations with differing community size and composition were created, reflecting the diversity observed in nature. In each case, the model was run to quasi-equilibrium under current mean annual temperature, and then subject to a 0.04 ˚C rise per year, over 100 years, or until communities reached a new quasi-equilibrium. I discovered the presence of strong bottom-up controls and some top-down indirect effects in the communities by examining the effects of rising temperatures and trophic vs. non-trophic interactions on the number of species extinctions, changes in community diversity, and formation of novel interactions. My results suggest that conserving plant species is key to preserving the biodiversity of a community during climate change.

Biography

Emily Baczyk is currently a senior at Choate Rosemary Hall in Wallingford, CT. She won second place in the Life Science category in her third time participating in the Connecticut Science and Engineering Fair for her ecological modeling project. In order to determine if certain conservation strategies would be best suited to preserve the biodiversity of ecological communities of different sizes or structures, she built a computer-based representation of a community and subjected it to climate change. Her research was conducted with a group at Yale University and the University of Connecticut with assistance from mentors in the Science Research Program at her high school. Outside of the classroom and lab, Emily is a four-year member of her school's Varsity Crew Team, on which she has participated as a rower, coxswain, and assistant coach. She also participates in other math and mathematical modeling competitions and is a member of her school's Math Team and Cycling Team. She will be attending Yale University in the fall where she will continue to explore mathematics and computer science.



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Trip Winner to the
Intel International Science and Engineering Fair
May 12 - 17, 2013, Phoenix, AZ

(Student information as of April 2013)

Mallory Madfes, Grade 12

Greenwich High School, Greenwich, CT

Project Title: Promotion of Wound Healing via a Novel Hydrophilic Dressing

Connecticut Science & Engineering Fair Awards

- Pfizer Life Sciences Awards --- Finalist - Life Science Senior High - CSF Medallion & Acrylic Award
- Alexion Biotechnology Awards --- 1st Place- Biotechnology Senior High- Trip to compete at Intel ISEF, $500 & trophy,

Abstract

Prolonged length of the inflammatory phase of wound-healing increases the likelihood of infection. Recent studies, however, have pointed to the unique properties of the Fibroblast Growth Factor 10 (FGF-10) and Chondroitin Sulfate (CS) as a means to accelerate initial wound-healing processes. FGF-10 is produced naturally and is dispatched to a wound site, where CS acts to stabilize and improve its function. *Candida albicans* (CA) are fungal pathogens that are causal agents of infection in humans. CA infections have become a major health concern, where more than 15% of individuals with weakened immune systems have superficial infections of the skin or mucous membranes. Current treatments for *Candidiasis* are limited to the use of orally administered antimycotics that include Flucanozole (FLUC), however adverse drug reactions are of concern. This research focuses on creating an alternate path for the delivery of FLUC directly to the wound site, with simultaneous delivery of CS to promote FGF-10 function. An innovative wound dressing was created that included effective concentrations of FLUC and CS. A novel elution methodology was devised to measure time-release of these agents into an aqueous medium. Results indicate that the maximum rate of FLUC and CS elution from the wound dressing occurs in the first hour of application (127 µg/hr & 0.62 mg/hr, respectively), where more than 60% of each active ingredient is time-released during a time that is most critical in the wound-healing process. The remaining FLUC & CS are delivered after 10 hours, after which time the dressing should be replaced.

Biography

Mallory Madfes is a senior at Greenwich High School enrolled in the Honors Science Research program. Last year she presented her research in Mycoremediation of Polychlorinated Biphenyl (PCB) soil contaminants with Pluerotus ostreatus at ISEF. She was awarded 4th place in the Environmental Management category. This year Mallory focused on creating a dual component dressing. This dressing releases two components that help the wound heal faster and fight a specific fungal infection. She received 1st in the Alexion Biotechnology category at the CT Science Fair and 3rd at the CT Junior Science and Humanities Symposium. In school, she serves as the VP of communication for her Student Government's executive committee. She has also started a new chapter for her youth group in Greenwich and is on the Varsity Outdoor Track team. Mallory plans to major in biomedical engineering at the University of Miami.

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Trip Winner to the
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May 12 - 17, 2013, Phoenix, AZ

(Student information as of April 2013)

Karim Kharbouch, Grade 12

Bridgeport Regional Aquaculture Center, Bridgeport, CT

Project Title: Optimization of the Cellulose Algea Sodium Chloride Battery

Connecticut Science & Engineering Fair Awards

- Dominion Millstone Power Station Physical Sciences Awards --- Finalist - Physical Sciences Senior High - CSF Medallion & Acrylic Award
- Urban School Challenge Awards with support from CASE --- 1st Place High School - $500 and Trophy, Medallion and trip to compete at Intel Int. Sci. & Eng. Fair
- EnergizeCT/eesmarts Future Sustainability Awards --- 1st Place High School - $800 Cash, Trophy, and Trip to Compete I-SWEEEP, Houston
- UTC Aerospace Systems Awards for Excellence in Engineering --- $1,000 cash and plaque for excellence in engineering
- University of New Haven 11-12th Grade Awards in Engineering & Science --- $100 for Top 11th or 12th Grade Project in Engineering: Materials and Bioengineering

Abstract

Metal based batteries are resource dependent and environmentally harmful. Cellulose based batteries have a low manufacturing cost, flexible and completely biodegradable; however, they are limited in performance due to the terrestrial plant cellulose fiber's low surface area. It is suggested that the use of algae cellulose will improve the efficacy of the cellulose battery due the high cellulose fiber surface area. The purpose of this experiment is to develop an algae cellulose battery that has a higher energy capacity than the existing terrestrial plant cellulose batteries. *Gracilaria tikvahiae* (Gracilaria) and *Laminaria saccharina* (Kelp) were used to construct three types of batteries; a Gracilaria battery, a Kelp based and a terrestrial plant cellulose battery (control). After multiple trials, a novel technique was developed to turn the algae into unique uniform paper sheets without damaging the cellulose fibers. The battery discharge was measured in milliamps over one hour and the capacity, milliamps-hour per gram, was calculated. As the milliamp values decreased the time interval for each value increased. The Kelp battery had the longest time interval per milliamp value; 1.845 milliamps for 47 minutes. The Kelp battery had a capacity of 0.0566 milliwatt-hours per gram. The Gracilaria battery had 0.0358 milliwatt-hours per gram and the cellulose battery had 0.0392 milliwatt-hours per gram. The data shows that Kelp cellulose increases the efficacy of the battery by 44.4% over the terrestrial cellulose cell. When connected in a series, three Kelp cells produced 2.1 volts surpassing the voltage of a AA battery by 0.6 volts.

Biography

Karim Kharbouch is a senior at Bridgeport Regional Aquaculture Science and Technology Education Center. This was his second year participating in the Connecticut Science and Engineering Fair. Karim first participated in the fair during his freshmen year of high school where he was a medalist in the Goodrich Engineering Excellence Award Category. This year, Karim conducted a research project in which he developed a unique seaweed (Kelp)-based material. This was used to construct a flexible, cost effective and completely biodegradable battery. He is the president of his school's National Honor Society and is also the president of the astronomy and rocketry Club. Through which he has been developing his engineering skills, designing and constructing various sized model rockets. He truly enjoys bringing his ideas to life which is why, in his spare time, he has designed and is currently building his own sail canoe. Karim is a highly motivated young man who plans to major in aerospace engineering and astrophysics in college.