2010

MASSACHUSETTS CLEAN TECHNOLOGY AWARDS

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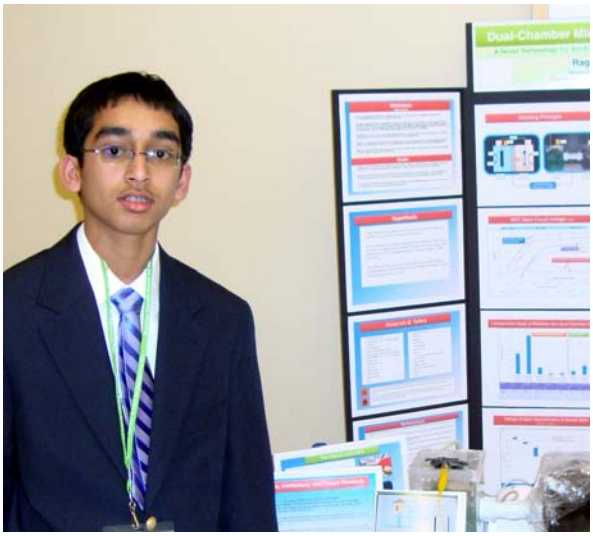

Region II: Central Massachusetts

Raghav Mishra: Shrewsbury High School, Shrewsbury

CleanTech Award (tie): "Dual Chamber Microbial Organic Fuel Cell"

About Me:

I am currently a sophomore at Shrewsbury High School, Shrewsbury, MA. I have a First Degree Black Belt in Ken-Ryu Kenpo Karate, and also enjoy playing tennis, soccer, and table tennis. My parents emigrated from India before I was born, so I like to maintain contact with this culture: I play the tabla and have performed in several concerts in the New England area, including at Boston's Hatch Shell, which was very exciting.

I'm a Youth Group Leader at Southborough where I help instruct yoga, organize cultural events, youth conferences, and service projects, including the UNICEF Children Radio Programs. I love soccer, but after playing for the boys junior and league for seven years, I have now become an official referee at MYSL (Maas Youth Soccer Association) games each year. I love music and video production, and at my high school, I work in the Educational TV studio on curriculum and educational productions. I am an active member of Varsity Math Club and the Engineering Club.

I am the youngest in the family of four. My older brother is a junior at Shrewsbury High School, my mother is a Psychology Professor, and my dad is a technical and business professional. It was my parents who brought it to my attention that developing clean technology products and renewable energy resources are critically important for America's future competiveness around the world.

MY PROJECT

The increasing health and environmental concerns around CO_2 emissions coupled with an increasing global demand for energy sources there is an urgent need for visionary technology systems that are capable of generating energy while preserving the environment. According to the recent data from US governmental agencies, energy production from renewable resources such as Wind and Solar are unlikely to grow at significant level without major R & D incentives and the demonstration of enabling technologies. The Microbial Fuel Cell (MFC) is an approach that holds a promise an attractive bio-energy alternative as it

takes advantage of special bacteria (isolated 15 years ago) to generate electricity while accomplishing the biodegradation of organic matters and wastewater.

I decided that I wanted to better understand the mechanism of charge transfer carried out by such special microorganisms available in organic matters, and to illustrate the feasibility of developing low-cost, environmental friendly fuel cell technology using bacteria from domestic wastewater and anaerobic sludge, without the use of expensive and hazardous chemical mediators.

In dual chamber microbial fuel cells (MFCs) there is a chamber for the anode, and a separate chamber for the cathode. Mediator-less microbial fuel cells are a recent discovery (originally in Korea), and apparently have redox enzymes such as a cytochromes on their external membranes as a path for the electron transfer.

I built my prototype MFCs using non-catalyzed Graphite Carbon electrodes, an Agar membrane, along with a variety of anodic substrates (i.e. domestic wastewater, anaerobic mixed consortia, and sucrose) combined with microbial communities of *adapted andophilic consortia*. After continuous operation for a four-week period, the cells demonstrated significant and sustainable power outputs. This confirmed that these bacteria grown under anaerobic conditions will induce effective electron discharge along with high substrate degradation. This means that this process can potentially be used to generate electricity from the wastewater, while removing contaminants from the waste water. Power densities for all the fuel cells that I built were extremely close to available data n current reported research.

I was able to discuss my results with Professor Bruce Logan, University of Pennsylvania, who is a pioneer in the field of MFC, and with Prof. Mark Nielsen at Harvard University. My project showed significant possibilities for these devices, and the work can be further used to develop the optimum cell design, and to select microbial communities to improve efficiency and power output of next generation MFCs. This would be a very exciting breakthrough for use in treating any organic waste.

[Editor's note: A more complete explanation of how a microbial fuel cell works can be found at http://en.wikipedia.org/wiki/Microbial_fuel_cell]