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Bio-Fuel Cell Power in Space Technology

What is your product? Our product is an array of high energy density ***Bio-Fuel cells*** that generate power for space hardware such as satellites, space shuttles, space stations, and shuttle ports**.** Space hardware configurations that range in size from small low-earth orbit satellites to larger communication satellites, the shuttle transport system and the space station, all require an efficient, reliable and practical source of on-board power for their operation. This power currently comes from two key sources: solar panels and hydrogen-based fuel cells. Our product involves the use of small, lightweight Bio-Fuel cells as backup power sources for such space technology by producing power from common, high energy Bio-Fuels such as alcohol, soybean oil, sugar, glycerol and even space shuttle waste. These cells offer important advantages over currently used solar cells in that they are easily repairable on-board, are relatively minute in size, and can function effectively 24 hours a day. In addition, Bio-Fuels have *3-5 times* the energy density of Hydrogen and are much safer to handle. Thus, Bio-Fuel cells are uniquely suited for space applications as convenient power sources because of these features.

What is the underlying technology of your product? Bio-Fuel cells create electricity in much the same way normal hydrogen fuel cells do except that they use enzymes as catalysts instead of noble metals like platinum. The cells produce electrical power akin to a battery, by an enzyme-catalyzed biological reaction (similar to reactions that produce energy in our bodies). Our technology incorporates the hardware necessary for operating Bio-Fuel cells in ambient Earth-like conditions in the space environment (by pressure and temperature regulation), in a self-contained package about ¼ the size of Hydrogen cells that deliver the same energy density. In addition, our technology allows for the use of multiple Bio-Fuels for power generation, thereby providing added flexibility and necessary redundancy in space operations.

Is your underlying technology unique? Bio-Fuel cells have never been explored as a possible power source for space applications in the past. Hydrogen cells require large hydrogen fuel and oxygen reservoirs and more importantly, pose serious explosion hazards in space applications (e.g. Apollo 13). Solar cells in satellites are bulky, difficult to deploy, have low efficiency and require sunlight for operation. Bio-Fuel cells, on the other hand, do not pose any explosion hazard, are miniature in size, are very efficient, and can operate continuously. Hence, these cells can be used as effective backup for 'dark' satellite operation in solar-powered satellites, or in the event of Hydrogen tank/cell failure on larger manned missions.

Is your idea innovative? Our idea is uniquely innovative because it opens brand new avenues in space mission design. In the quest to devise new long-term manned space missions to the Moon and potentially Mars, the Bio-Fuel cell approach blends extremely well with the lean nature of such missions. The flexibility of the cells to work on a range of fuels allows for the creation of mission *Bio-cycles*. These cycles may involve the production of the necessary fuel perhaps by plant growth or from other biological waste products, the employment of the fuel, and the recycling of the by-products (water and CO_2) for other purposes (*water:* drinking, coolant, air humidifier, etc.; *CO_2:* plant respiration).

Who will buy it? Particularly because of its safety, efficiency, and versatility, the target market for our product is the companies associated with NASA's new '*Moon, Mars and Beyond'* manned space flight program and various other manned space projects such as the space station, the shuttle, and the Soyuz capsule. Bio-Fuel cells can also serve as a new power alternative to low energy density Li-ion batteries for the large numbers (80/year) of solar-powered satellites launched today, particularly industry and university nano-satellites with ever-increasing energy demands. Potential buyers include NASA, CEV suppliers such as Boeing and Lockheed Martin, as well as university satellite projects and small satellite companies.

Why will they buy? The key reasons to use Bio-Fuel cells as a backup to current options are that they are safe, versatile and small. In the quest to design successful missions for long distance travel (to the moon or Mars), it is vital that power sources used are reliable, safe and easily packaged. Bio-Fuel cells satisfy these requirements in addition to being adaptable and integrable in a system bio-cycle: *biological raw materials⇨ fuel⇨ useful by-products*.

What is the size of the market? NASA's FY 2007 budget provides $920.7 million for Exploration and Human Systems, most of which is devoted to the Crew Exploration Vehicle (CEV) project for manned space travel to the moon. The on-board power requirements of this vehicle involving hydrogen and oxygen tanks and fuels cells could potentially account for about 5% of this amount in development and fabrication costs. Initial focus on using Bio-Fuel cells as alternative backup to solar cells for the ($3 billion/yr) satellite industry represents a market of about *$100 million annually*.

How do you anticipate developing IP protection for your technology? The technology transfer office at Saint Louis University has acquired a broad patent for the pioneering fuel cell research performed by the Minteer group (SLU Chemistry). Our group intends to scientifically validate our engineering technology for Bio-Fuel cell space applications by a nano-satellite experiment, followed by patenting the engineering design concept.

More information at: http://cubesat.slu.edu