CPS Plasma Page

Published by the Coalition for Plasma Science, Vol.3, No.1 March, 2000

University of Washington Researches Plasmas for Outer and Inner Space

It sounds like a "droid" straight out of Star Wars. That's not a coincidence because a new plasma propulsion system dubbed M2P2 can greatly boost spacecraft speeds, perhaps to 10 times the velocity of the space shuttle, University of Washington scientists believe.

NASA's Institute for Advanced Concepts last week awarded a two-year, $500,000 grant to a UW team headed by geophysicist Robert Winglee to continue research on Mini-Magnetospheric Plasma Propulsion. If laboratory work and tests in space succeed, he hopes in 10 years to launch an M2P2-equipped spacecraft that would become the first from Earth to leave the solar system. That would be quite a feat, considering the craft would have to overtake Voyager I, launched in 1977 and now about 6.8 billion miles away, but still within the solar system.

Their system would use a plasma chamber about the size of a large pickle jar, perhaps 10 inches by 10 inches, attached to a spacecraft. Solar cells and solenoid coils would power the creation of a dense magnetized plasma that would create an electromagnetic field 10 to 12 miles in radius around the spacecraft. The field would interact with and be dragged by the solar wind.

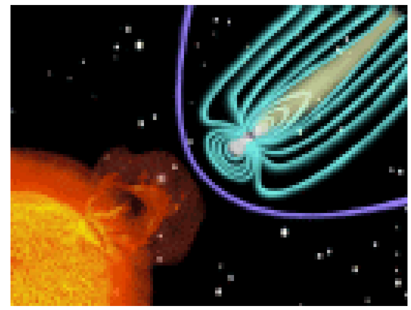
Creating a field would be akin to raising a giant sail and harnessing the solar wind, which moves at 780,000 to 1.8 million miles an hour - or "here to Washington D.C. in 10 seconds," Winglee said.

If tests on M2P2 succeed, Winglee expects the system's first use in space will come on a mission NASA has already scheduled. "If it works, we'll have some real fun then," he said.

For further information please contact Robert Winglee at winglee@geophys.washington.edu.

The University of Washington is also using plasmas in biomedical research to coat medical implants in a way that will prevent the body from rejecting them as foreign material.

More than half a billion medical devices, ranging from simple catheters to heart valves and artificial hips, are implanted in patients every year. Often these devices deliver only temporary fixes. The body's natural response to foreign material - whether it's a medical implant or a bullet - is to wall it off with scar-like tissue. Frequently this reaction disrupts the device's performance and necessitates further medical intervention.



The M2P2 design mimics nature. The sun creates mini-magnetospheres or 'magnetic clouds' during coronal mass ejections, as seen in the figure.

A team lead by University of Washington bioengineer Buddy Ratner has devised a complex plasma-based process for coating artificial materials so their surfaces can attract and bind specific proteins, which trigger the body's natural healing processes, aiding acceptance of the foreign material. The final coating of a Teflon-like flouropolymer is applied through a gas-phase plasma deposition process.

For further information on this process please contact Buddy Ratner at ratner@uweb.engr.washington.edu.

Air Monitor Uses Plasmas to Detect Hazardous Elements

Researchers at the Department of Energy's Los Alamos National Laboratory have developed a portable, ultrasensitive air particulate monitor that uses plasma to instantly and continuously identify virtually all known constituent elements in the periodic table and their relative concentrations.

"I've no doubt that this portable instrument will greatly reduce, or in some cases eliminate, the risk of worker exposure to hazards related to operating processes," said principal investigator Yixian Duan of Los Alamos' Analytical Chemistry Sciences Group. "The instrument is ideal for work sites that handle hazardous materials."

The inexpensive device, which can be used indoors or outdoors, takes advantage of the fact that all elements in the periodic table have well-characterized atomic energy levels. A miniature microwave plasma source in the device excites the atoms, permitting quick, easy identification of air particulate samples based on the energy levels of those elements. With a minor modification, the device also can identify elements in solution.

The monitor is ideal for facilities that handle highly hazardous materials such as beryllium, Duan said. Exposure of workers who are sensitized to beryllium can lead to chronic beryllium disease, which scars the lungs and can be fatal. The real-time feedback this monitor provides allows workers to avoid overexposure.

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Coalition for Plasma Science Brings Excitement About Science Education and Plasmas to Capitol Hill

How do you keep busy Congressional Staffers at a science talk beyond their scheduled lunch hours? The same way you capture the imagination of a classroom of students, according to Professor David Newman, by pulling them in with vibrant, interactive hands-on demonstrations.

On March 14, 2000, in the U.S. Capitol, Newman addressed a packed room of about 60 Congressional Staff plus Congressmen and other guests at a luncheon briefing entitled, "Educating Kids and Exciting Teachers about Science: A Model from the Plasma Science Community." Sponsored and organized by the Coalition for Plasma Science (CPS), the event included introductory remarks by the event's Congressional Hosts, Representative Vernon Ehlers and Representative Rush Holt, each making compelling remarks about the importance of keeping a vibrant science curriculum in America's K-12 classrooms.

The featured speaker, David Newman, Professor of Physics at the University of Alaska, kept the room full of mostly political scientists glued to their seats as he taught about plasmas while making the case for more exciting science education curricula. In between his impassioned remarks, he provided several demonstrations, which helped build his case that science — and plasmas — can be presented in a format that is both educational and interesting for students of all ages. His method worked, as a number of staff members were enticed to "play" with various hands-on experiments at the end of the session.

CPS Chairman Dr. Gerald L. Rogoff acted as M.C. for the event, making introductory remarks about the Coalition, introducing the speakers, and directing attention to the CPS material that was distributed to the attendees, including a list of CPS member organizations and institutions, an educational brochure about plasmas, and an outline of plasma and science outreach activities organized by CPS members.

David Newman shows teachers how a plasma will affect a light bulb.

For further information about this event contact: Johanna Hardy, jhardy@mit.edu

The Semiconductor Industry: Working to Eliminate Global Warming PFC Emissions while Increasing Productivity

Perflourocompounds (PFCs) are released into the atmosphere as part of several industrial processes (e.g., refrigeration, magnesium and aluminum production, and chip manufacturing). Recently emissions of these gases have raised concerns due to their long life and their potential for increasing global warming. For example, the PFC Tetrafluoro-methane has an estimated lifetime in the atmosphere of 50,000 years. Emission of one kilogram of this gas equates to 6500 kg in carbon equivalent. Although PFC emissions from the semiconductor industry represented less than one-thousandth of the total US greenhouse gas released in 1997, the industry is committed to further reducing these emissions. The use of high-density plasmas is contributing to this effort.

In the semiconductor industry, PFC gases are used as part of the chip manufacturing process to etch materials and clean residues from chemical vapor deposition (CVD) reactors. Chemical vapor deposition is the main process used to deposit thin films during fabrication of semiconductor chips. During this process, residues accumulate on the chamber walls. To prevent buildup and potential contamination of the chip, these chambers must be cleaned periodically.

Typically, a plasma is used inside the chamber to release the fluorine (the cleaning agent) from the PFC molecules, allowing it to react with the deposition residues. To prevent damage to the deposition chamber, the plasma must be sustained at a low density. Consequently the plasma is not able to break down the PFC molecules completely. Although attempts to improve such cleaning processes have resulted in substantial emission reduction, they still fall short of the 90% emission reduction goal.

A new process that uses Nitrogen Triflouride (NF_3) gas in a remote plasma source will make cleaning the CVD chamber both more economically viable and more environmentally friendly. Developed and commercialized by Applied Materials in California, this 'Remote Clean' technology is more effective than previous approaches, and healthier for the environment. Because the plasma is located upstream of the main deposition chamber, it is possible to use a high-density plasma to break down the NF_3 molecules without damaging the deposition chamber itself. This plasma is able to break down more than 99% of the NF_3, resulting in negligible emission of global warming gases. This near-complete dissociation of the NF_3 source gas, combined with the high cleaning rate provided by this method, reduces the cleaning time in the chamber by up to 60% compared with conventional cleaning processes. The process also contributes to increased uptime, resulting in higher system output and a significant increase in process efficiency**.**

In applications where plasmas can be used as part of the manufacturing process, their remarkable properties can be exploited to design "clean" manufacturing technologies. The semiconductor industry is demonstrating that green manufacturing techniques can be developed and implemented under severe cost constraints.

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These brief summaries are drawn from several sources and are issued throughout the year. For more information please contact the source given at the end of each article or the editor: rivenberg@psfc.mit.edu; 617/253-8101