CPS Plasma Page

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Congressional Luncheon Speaker Shows How Plasma Affects the Digital World

At a September 16 luncheon sponsored by the Coalition for Plasma Science, about 100 Congressional representatives and staffers met in the Cannon House Office Building, Washington, DC, to learn how plasmas are key to the production of semiconductor chips. In a talk entitled "The Digital World: How Plasmas Make Computers Smarter, Faster, Cheaper," Dr. Joel Cook, Principal Technologist for Lam Research Corporation, discussed how semiconductor chips would be technically impossible or prohibitively expensive to produce if it were not for plasmas.

Through animated slides, Cook showed how plasma can etch precise holes and channels in chips, creating room for more transistors and wiring per square centimeter, making the chip smarter and smaller. As these chips have become faster, more versatile and less expensive, they have become nearly ubiquitous – in everything from computers, cameras and cell phones to specialized defense and national security tools.

Joel Cook shows Congressional staffers how plasmas are involved in the manufacture of semiconductors.

The speaker was introduced by CPS Chair, Lee Berry. This was the fourth in a series of Congressional luncheons devoted to the topic of plasmas.

Plasmatron Could Cut Oil Consumption, Emissions

A bus in Indiana is the latest laboratory for MIT's plasmatron reformer, first mentioned in the *Plasma Page* in January 1998. Its developers believe this small device could significantly cut the nation's oil consumption as well as noxious emissions from a variety of vehicles.

The researchers and colleagues from industry report that the plasmatron, used with an exhaust treatment catalyst on a diesel engine bus, removed up to 90 percent of nitrogen oxides (NOx) from the bus's emissions. Nitrogen oxides are the primary components of smog.

Daniel R. Cohn, one of the leaders of the team and head of the Plasma Technology Division at MIT's Plasma Science and Fusion Center, explained how the device also helps economize on fuel. He explained that "the absorption catalyst approach under consideration for diesel exhaust NOx removal requires additional fuel to work. The plasmatron reformer reduced that amount of fuel by a factor of two."

Cohn noted that the plasmatron reformer also allowed the NOx absorption catalyst to be effective at the low exhaust temperatures characteristic of urban use.

These results, reported at a U.S. Department of Energy (DOE) Diesel Engine Emissions Reduction meeting in August, indicate that the plasmatron reformer, in conjunction with an NOx absorber catalyst, could be one of the most promising ways to meet stricter emissions limits for all heavy trucks and buses. The Environmental Protection Agency plans to institute the new limits by 2007.

"Diesel-engine vehicles generally do not have exhaust treatment systems," Cohn said, adding that treating diesel exhaust is much more difficult than gasoline exhaust.

Under development for the last six years, the plasmatron is an on board "oil reformer" that uses a plasma to convert a variety of fuels into high-quality, hydrogen-rich gas. Adding a relatively modest amount of such gas to the gasoline powering a car or to a diesel vehicle's exhaust is known to have benefits for cutting the emissions of pollutants. "Prior to the plasmatron reformer development, there was no attractive way to produce that hydrogen on board," said Cohn.

Cohn and his group are working with ArvinMeritor, a major automotive and heavy truck components company that has licensed the plasmatron technology from MIT. The bus engine tests were performed at the company's facility in Columbus, Indiana, by an ArvinMeritor team.

The team is finding that the device could make vehicles cleaner and more efficient, with a potentially significant impact on oil consumption. "If widespread use of plasmatron hydrogen-enhanced gasoline engines could eventually increase the average efficiency of cars and other light-duty vehicles by 20 percent, the amount of gasoline that could be saved would be around 25 billion gallons a year," Cohn said. "That corresponds to around 70 percent of the oil that is currently imported by the United States from the Middle East."

The work is funded by the DOE's FreedomCAR and Vehicle Technologies Program and by ArvinMeritor and is an outgrowth of decades of research at MIT aimed at the development of fusion power sources.

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Princeton Researchers Study Plasma Sterilization

While considerable work has been done on sterilization using plasmas, new approaches continue to be explored. In one such approach, scientists at the Princeton Plasma Physics Laboratory (PPPL) are testing methods for rapidly sterilizing packaging materials using plasmas.

Hundreds of billions of plastic food and beverage containers are manufactured each year in the U.S. All of these packages must undergo sterilization, which at present is done using high temperatures or chemicals. But chemicals often leave a residue that can affect the safety and taste of the product and produce undesirable waste. Heat is effective, but requires the use of costly heat-resistant plastics that can withstand sterilization temperatures.

At PPPL, a team is conducting a small-scale research project studying plasma sterilization. "We have experiments indicating it is possible to kill microbes using a new plasma approach," noted John Schmidt, lead scientist of PPPL's Plasma Sterilization project. Schmidt cautioned, however, that the research is preliminary.

In the PPPL experiment, a one-inch-diameter metal sphere, with a known number of non-toxic spores on its surface, is mounted at the center of a vacuum chamber. After an experiment, the number of spores killed is determined.

PPPL researchers start with low-pressure hydrogen plasmas with temperatures in the range of 50,000 degrees centigrade. At that temperature, the hydrogen ions are moving much too slowly to kill spores quickly. Rapidly pulsing a 50-kilovolt potential between the sphere and the vacuum chamber solves the problem. The sphere is charged negatively and the vessel is at ground. Under these circumstances, the positively charged hydrogen ions accelerate toward the sphere in pulses energetic enough for the ions to pierce the hard outer shell and soft inner core of the spore.

This approach contrasts with past approaches in having the potential for rapid sterilization suitable for bottling line applications.

Recent experiments employed 4,000 10-microsecond pulses, which reduced the population of live spores by a factor of 100-1000.

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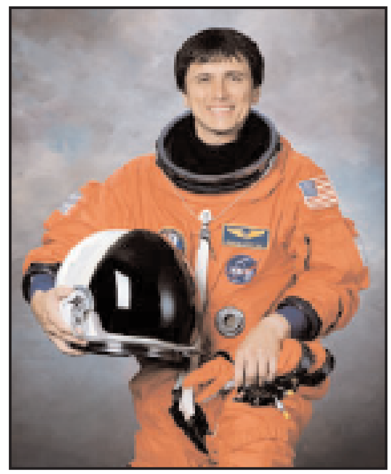
Astronaut Chang-Diaz Wins Discover Magazine Award



NASA Astronaut Franklin Chang-Diaz has won Discover magazine's 2003 Innovation Award for Space Science and Technology, in the Space Explorer category. Chang-Diaz, a plasma physicist and world-class rocket propulsion scientist, spoke about using plasma for space travel at a CPS Congressional Luncheon in March 2001. The prestigious awards are to be announced in the magazine's November issue.

These 14th annual awards honor scientists whose work has benefited the space program and all humanity. The Innovation Awards for Space Science and Technology are presented in the categories of Space Explorer, Communications, Space Scientists, Technology for Humanity, and Aerospace.

Chang-Diaz is a veteran of seven space flights, a record he shares with one other astronaut. He also is director of the Advanced Space Propulsion Laboratory at NASA's Johnson Space Center in Houston. There he and his team are developing the Variable Specific Impulse Magnetoplasma Rocket (VASIMR) Engine, a concept that may eventually enable humans to explore more distant parts of our solar system and perhaps beyond.

Chang-Diaz describes VASIMR as a system using radio waves that heat rocket fuel – in this case hydrogen – to super hot temperatures. "Rockets tend to work much better the hotter the exhaust is and the plasma allows you to go to temperatures (of) millions of degrees rather than thousands of degrees (as) in a conventional rocket engine," he said.

Thrust from the plasma engine could boost a spacecraft for a longer time and with better efficiency than conventional engines.

The heart of VASIMR is three magnetic cells that ionize the feed gas, heat the resulting plasma, and direct the plasma flow.

A key feature of the plasma engine is its ability to throttle the plasma, which allows it to increase or decrease in thrust when needed to enter or escape a planet's gravity. This is analogous to a car using a lower gear to climb a hill, then shifting to a higher gear on the open highway.

Born and raised in Costa Rica, Chang-Diaz came to the United States after graduating from high school in his native country in 1967. He arrived in Connecticut speaking no English and with only $50 in his pocket.

He graduated from Hartford (Conn.) High School in 1969 and earned a B.S. in mechanical engineering from the University of Connecticut in 1973. Chang-Diaz got his Ph.D. in applied plasma physics from the Massachusetts Institute of Technology in 1977. He later worked in the nation's controlled fusion program.

He became an astronaut in August 1981. His first space flight, in January 1986, was a satellite deployment and research mission. His most recent flight was an International Space Station assembly and crew exchange mission in June 2002. He made three spacewalks during that flight.

For more information on Chang-Diaz:
•http://www.jsc.nasa.gov/Bios/
•http://www.space.com/businesstechnology/technology/plasma_propulsion_000616.html