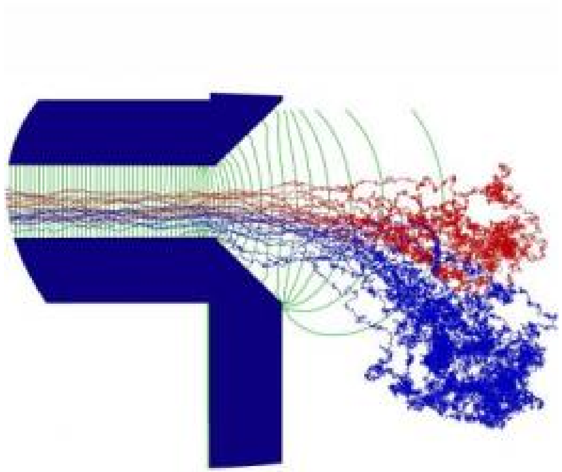
New INL invention could aid Mars probes' search for life

May 24 2010



The next generation of Mars rovers will use mass spectrometers to search for signs of life, such as amino acids, on the Red Planet. Most current mass spectrometers rely heavily on airflow to guide ionized soil samples through an inlet, down a channel and into a trap for analysis. But this system is less than ideal for Mars missions like ExoMars, due to launch in 2018: airflow requires pumps, and pumps are heavy and energy-hungry. INL's new technology guides ions efficiently using versatile, complex electric fields. The invention could greatly reduce the need for pumps, helping make ExoMars' life-detecting tools smaller, cheaper and more sensitive. Credit: Idaho National Laboratory

The next generation of Mars rovers could have smaller, cheaper, more robust and more sensitive life-detecting instruments, thanks to a new invention by scientists at the U.S. Department of Energy's Idaho

National Laboratory.

The INL team has come up with an efficient new way to generate complex electric fields, which will make it easier to direct ions, or charged particles, along specified paths. The researchers have now filed a patent application for their Total Ion Control method, a key advance in the field of mass spectrometry. Equipment based on TIC could make the Mars Organic Molecule Analyzer (MOMA) — part of the ExoMars mission scheduled for launch in 2018 — a better life-detecting tool.

"This is a novel way to shape electric fields for moving ions around," said INL engineer Tim McJunkin, who helped develop the new technology. "It can improve MOMA, and it could improve commercial instruments."

Mass spectrometry allows scientists to determine a sample's chemical composition. The technique has many applications, from flagging explosives at airport screening stations to determining how medicines move through the human body. And it's one of the best ways to find signs of life, such as proteins and amino acids, on other worlds.

In some mass spectrometers, a sample — for instance, a few grains of Martian soil — is vaporized, often with a laser. The gas is then ionized, and the charged particles flow through an inlet, down a channel and into an ion trap. The ions are then identified based on details of their movement, which depend on their mass and electrical charge.

To get ions to stream into the trap — rather than hit the channel walls and "die" — most current mass spectrometers rely heavily on air flow created by pumps. This system is less than ideal for Mars missions, though; pumps are heavy, and they use a lot of energy.

TIC could assist spectrometers such as MOMA. New TIC-based ion inlets greatly reduce the need for pumps, getting good ion flow solely by generating versatile, intricate electric fields. Since ions are charged particles, properly constructed fields can guide ions safely to the trap all by themselves.

A few other ion inlet technologies attempt to do the same thing, but INL's invention boasts many advantages. For one thing, TIC-based inlets should be cheaper and more robust than their competitors, because they're simpler to construct and have fewer parts. Other devices that generate elaborate, complex electric fields tend to be elaborate and complex themselves. They have multiple, precisely configured electrodes interspersed with other materials that serve as insulators. And they require complicated control electronics, too.

TIC-based solutions, on the other hand, use only a single electrode, and they don't need any insulators. They can be made from many different semi-conducting materials, such as graphite, glass, silicon or polymers. And the fields TIC inlets can generate are not tied to their own shape, meaning they can be incorporated into a wider range of spectrometer designs.

Because of their simple construction, TIC-based inlets are also much smaller and lighter than other types, weighing less than an ounce. This minuscule mass is a big plus for space missions, since it currently costs about $10,000 to put one pound of payload into Earth orbit (and far more to get that payload to Mars).

Energy consumption is another big concern for missions like ExoMars, which is a joint effort between the European Space Agency and NASA. "The ExoMars rover will be powered by nothing but solar," said INL scientist and TIC co-inventor Jill Scott. "So all of its instrument components will have to be very low-power."

INL's new invention hits that mark, too. At a maximum, it requires just 100 milliwatts of power — one thousand times less than a 100-watt light bulb.

And on top of these advantages, TIC delivers outstanding performance. Tests at INL have shown that TIC inlets shepherd 10 times as many ions down the pike and into the trap as commercially available inlets do. Such efficiency is key to instruments like MOMA, since any signs of life in the Martian soil will likely be few and far between, if they exist at all.

The INL researchers are currently talking to Johns Hopkins University scientist LuAnn Becker, leader of the U.S. MOMA team, about incorporating a TIC-based inlet into MOMA. But the new invention could find many other applications in many different fields, according to Scott.

"This is an enabling technology," she said. "If you want to move ions around cheaply and robustly, and without much weight, this is the way to do it."

Provided by Idaho National Laboratory