



## Alpha-Voltaic Sources Using Liquid Ga as Conversion Medium

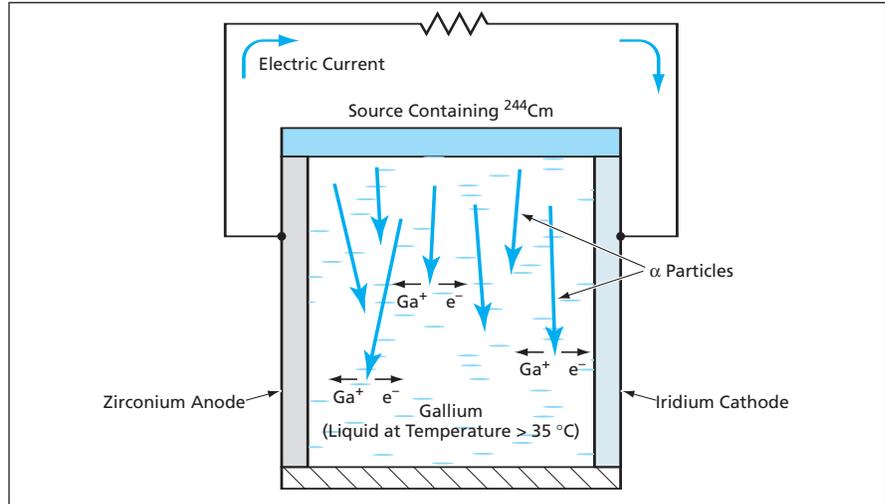
These units would offer long life and high energy-conversion efficiency.

NASA's Jet Propulsion Laboratory, Pasadena, California

A family of proposed miniature sources of power would exploit the direct conversion of the kinetic energy of  $\alpha$  particles into electricity. In addition to having long operational lives, these sources are expected to operate with energy-conversion efficiencies from 70 to 90 percent.

A power source as proposed (see figure) would be an electrolytic cell in which liquid gallium would serve as both an electrolyte and an energy-conversion medium. The cell would contain an iridium cathode and a zirconium anode. The  $\alpha$  particles, each with a kinetic energy  $\sim 5.8$  MeV, would be emitted by radioactive decay of  $^{244}\text{Cm}$ , which has a half-life of 18 years. The  $^{244}\text{Cm}$  source would be positioned so that the  $\alpha$  particles would enter the liquid gallium, where their kinetic energy would be dissipated mostly through ionization of Ga atoms, creating  $\text{Ga}^+$  ions and free electrons. The electrons would be collected by iridium cathode, and the  $\text{Ga}^+$  ions would be neutralized at the zirconium cathode by electrons returning after flowing through an external circuit.

Gallium is a candidate for use as the electrolyte and the energy-conversion medium because in the liquid state it is a semimetal: its electrical conductivity is greater than that of a typical semiconductor but small in comparison with the conductivities of metals. Consequently, in liquid gallium, electrons and  $\text{Ga}^+$  can exist without immediate recombination and can be moved by electric fields. It is expected that electric fields, resulting at least partly from the difference between



Liquid Gallium in an Electrolytic Cell would be ionized by impinging  $\alpha$  particles. The resulting electric charges would be collected at the electrodes.

the work functions of the electrode metals, would move the electrons and ions to their respective electrodes. The open-circuit potential of the cell is expected to be 1.62 V — equal to the difference between the work functions of iridium and zirconium.

Unlike in a solid-state energy conversion medium, the impingement of energetic  $\alpha$  particles would not give rise to displacement damage in the liquid gallium. Hence, the cell should have a long life, limited only by the half-life of  $^{244}\text{Cm}$ . A cell having a volume less than 25 mm<sup>3</sup>, containing 1 curie of  $^{244}\text{Cm}$  (the curie is a unit of radioactivity equal to  $3.7 \times 10^{10}$  disintegrations per second)

is expected to deliver a current between 7 and 12 mA, which, at the expected open-circuit potential, would provide a power in the approximate range of 11 to 20 mW.

*This work was done by Jagdish U. Patel, Jean-Pierre Fleuriel, and G. Jeffrey Snyder of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).*

*This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Management Office-JPL at (818) 354-7770. Refer to NPO-30322.*

## Ice-Borehole Probe

The art of borehole imaging has been extended to deep, cold, wet, high-pressure environments.

NASA's Jet Propulsion Laboratory, Pasadena, California

An instrumentation system has been developed for studying interactions between a glacier or ice sheet and the underlying rock and/or soil. Prior borehole imaging systems have been used in well-drilling and mineral-exploration

applications and for studying relatively thin valley glaciers, but have not been used for studying thick ice sheets like those of Antarctica.

The system includes a cylindrical imaging probe that is lowered into a hole

that has been bored through the ice to the ice/bedrock interface by use of an established hot-water-jet technique. The images acquired by the cameras yield information on the movement of the ice relative to the bedrock and on