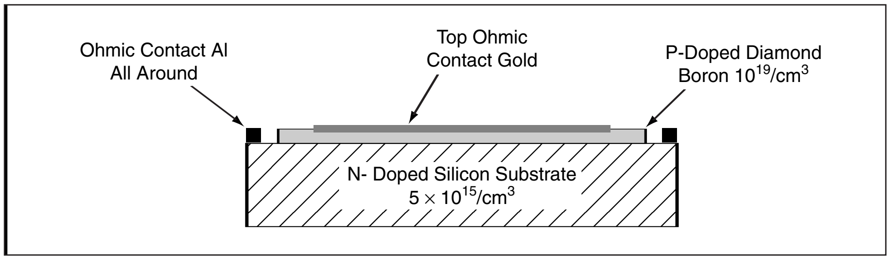
Alpha-Voltaic Sources Using Diamond as Conversion Medium

Compact, long-lived solid-state devices would tolerate wide temperature ranges.

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 α particles into electricity in diamond semiconductor diodes. These power sources would function over a wide range of temperatures encountered in terrestrial and outer-space environments. These sources are expected to have operational lifetimes of 10 to 20 years and energy conversion efficiencies >35 percent.



This **Diamond Diode** is one of two that would be sandwiched together with a thin film of ^{244}Cm, which is a source of α particles. The sandwich structure would constitute an alpha-voltaic device.

A power source according to the proposal would include a pair of devices like that shown in the figure. Each device would contain Schottky and p/n diode devices made from high-band-gap, radiation-hard diamond substrates. The n and p layers in the diode portion would be doped sparsely (<10^{14} cm^{-3}) in order to maximize the volume of the depletion region and thereby maximize efficiency. The diode layers would be supported by an undoped diamond substrate.

The source of α particles would be a thin film of ^{244}Cm (half-life 18 years) sandwiched between the two paired devices. The sandwich arrangement would force almost every α particle to go through the active volume of at least one of the devices. Typical α particle track lengths in the devices would range from 20 to 30 microns. The α particles would be made to stop only in the undoped substrates to prevent damage to the crystalline structures of the diode portions.

The overall dimensions of a typical source are expected to be about 2 by 2 by 1 mm. Assuming an initial ^{244}Cm mass of 20 mg, the estimated initial output of the source is 20 mW (a current of 20 mA at a potential of 1 V).

This work was done by Jagdish U. Patel, Jean-Pierre Fleurial, and Elizabeth Kolawa 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-30323.

White-Light Whispering-Gallery-Mode Optical Resonators

Overlapping resonator modes are exploited to obtain wide, high-*Q* spectra.

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Whispering-gallery-mode (WGM) optical resonators can be designed to exhibit continuous spectra over wide wavelength bands (in effect, white-light spectra), with ultrahigh values of the resonance quality factor (*Q*) that are nearly independent of frequency. White-light WGM resonators have potential as superior alternatives to (1) larger, conventional optical resonators in ring-down spectroscopy, and (2) optical-resonator/electro-optical-modulator structures used in coupling of microwave and optical signals in atomic clocks. In these and other potential applications, the use of white-light WGM resonators makes it possible to relax the requirement of high-frequency stability of lasers, thereby enabling the use of cheaper lasers.

In designing a white-light WGM resonator, one exploits the fact that the density of the mode spectrum increases predictably with the thickness of the

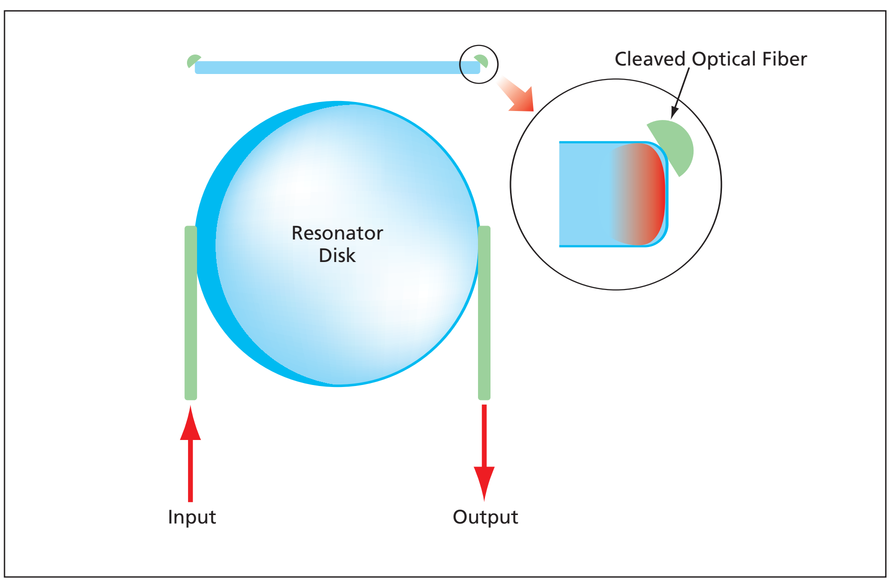

Figure 1. **Cleaved Optical Fibers** tangent to the rim of the resonator disk are used to couple light into and out of the disk. The fibers are shifted with respect to the middle of the rim to obtain a high degree of interaction with all the WGM modes.