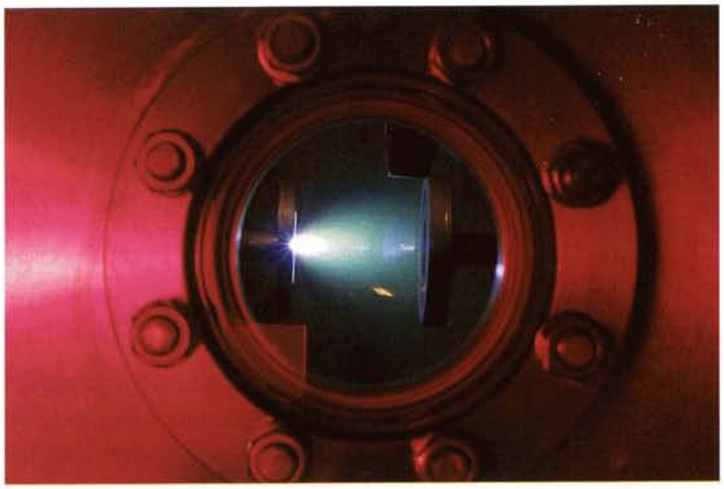
SUPERCONDUCTING MATERIALS



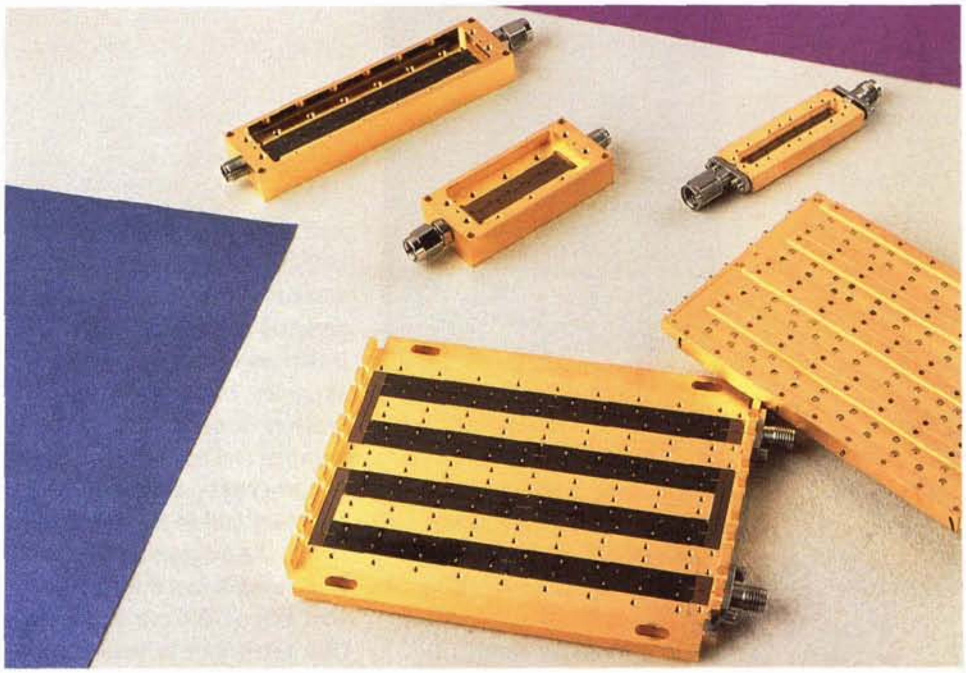
Superconductivity is the phenomenon wherein the electrical resistance of a metal disappears when the metal is cooled. Superconductivity occurs in a variety of metals, but only when they are cooled to extremely low temperatures, near absolute zero.

Ever since the discovery of superconductivity in 1911, researchers have sought to raise the temperature at which superconductivity occurs, because that would make possible exciting applications of resistance-free electricity long thought impractical in light of the cooling requirement — for example, supercomputers with speed and capacity several orders of magnitude beyond today's capabilities; frictionless superspeed trains levitated by magnetic force; transmission lines that suffer no power loss through resistance; and supermagnets that could significantly enhance the medical diagnostic technology of magnetic resonance imaging (MRI).

In 1986, researchers achieved a breakthrough by identifying a new class of high temperature superconducting (HTS) materials. The "high temperature" is high only in the relative sense; these oxide materials remain superconductive above 30 degrees Kelvin, which corresponds to 243 degrees below zero on the more familiar Centigrade scale. However, some HTS materials superconduct at temperatures more than 50 degrees higher than the initial applications of superconductivity. That makes them easier to cool and easier to use, opening up a wide range of applications to take advantage of the superconductor's special properties: zero resistance, magnetic field exclusion, low noise and extremely low power loss for high frequency electronics.

With the advent of HTS materials, superconductors have begun to emerge from the laboratory and appear in practical applications.

A pioneer in this explosively advancing technology is Superconducting Technologies, Inc. (STI), Santa Barbara, California. STI's basic products are high quality thin films, sold to manufacturers of communications systems and military systems, who use them for in-house fabrication and component development. STI also produces custom circuits and components — resonators, filters, oscillators, microwave mixers, etc. — for manufacturers who prefer to have the superconducting fabrication and assembly done by specialists. STI uses thallium, the highest temperature material for making HTS. Thallium remains superconductive at temperatures above 77 degrees Kelvin and can be cooled to working temperature by a liquid nitrogen system instead of the



more difficult and more expensive helium method.

At left, HTS is being produced by a laser ablation system. **Below,** an STI scientist displays the result, a three-inch wafer of HTS material. **At right** is a representative application: microwave circuits used in radars to reduce interference; the dark brown strips are made of HTS material. **At lower right** is a closed cycle stirling cooler used to cool HTS subsystems to 77 degrees Kelvin; it has a one-quart capacity and the same electricity as an ordinary light bulb.

In addition to producing films, circuits and components, STI provides a wide range of foundry services, allowing access to HTS technology by company engineers who have not had previous experience in HTS. A number of government agencies and several large companies are using STI's foundry facility and personnel expertise to design and develop HTS circuits and components for specific applications.

STI credits NASA with a technological assist in the company's climb to a leadership position in the development and commercialization of superconducting products. Founded in 1986, STI has worked with two NASA centers — Lewis Research Center and Jet Propulsion Laboratory (JPL) — and advanced its own technology by adapting to NASA requirements. Says Joseph M. Madden, manager of sales and applications, "In fabricating antenna circuits for Lewis and other devices for JPL, we refined our standard production recipe for circuits. This now enables us to use the same standard production recipe for our production work."