N91-24080

AEROSPACE APPLICATIONS OF HIGH TEMPERATURE SUPERCONDUCTIVITY

V. O. Heinen and D. J. Connolly
National Aeronautics and Space Administration
Lewis Research Center
Cleveland, OH 44135

Abstract

Space application of high-temperature superconducting (HTS) materials may occur before most terrestrial applications because of the passive cooling possibilities in space and because of the economic feasibility of introducing an expensive new technology which has a significant system benefit in space. NASA Lewis Research Center has an ongoing program to develop space technology capitalizing on the potential benefit of HTS materials. The applications being pursued include space communications, power and propulsion systems, and magnetic bearings. In addition, NASA Lewis is pursuing materials research to improve the performance of HTS materials for space applications. This paper will discuss some of the applications we are pursuing. The HTS communications program is described in another paper in this proceedings.

Introduction

The discovery, in 1987, of ceramic materials which are superconducting at temperatures above 77 K initiated a new era in which superconducting technology could be envisioned as enabling a host of exciting new systems in the power, transportation, communications, and data processing industries. In the succeeding three years there has been steady progress in research to address concerns for the limitations of the new superconducting materials. The availability of thallium based materials which are superconducting up to 125 K has become firmly established. Yttrium based films with critical current densities (J_c) above $2X10^6$ amp/cm^2 at 77 K in magnetic fields of several Tesla, can now be routinely made by numerous laboratories world wide.

Impressive progress is also being made in the development of bulk superconducting materials with high critical current density - a parameter that is essential to power and propulsion applications. Various approaches to microstructural control have yielded J_c values near 10^7 A/cm^2 at 77 K and 1 Tesla.[1]

The application of superconducting technology has previously been limited by the requirement of cooling to near liquid helium temperatures. A superconducting transition temperature above 77 K and the cold background temperature in space reduce the cooling requirements significantly. The natural cooling ability of space as well as the acceptability, in space-based applications, of high up-front development costs suggest that space application will lead the way in exploiting the promise of high-temperature superconductivity (HTS).

The NASA Lewis Research Center is performing materials research to improve the performance of HTS materials in a space environment and has established a program to develop HTS technology for space applications.

Concluding Remarks

HTS materials can offer many improvements and advantages over conventional technology for both space and ground based applications. A complete system analysis must be done to determine the total benefits from using HTS materials. Although many applications of HTS materials are near term, much materials research remains to be done to improve the properties and determine the reliability of these materials.

Acknowledgments

The authors thank P. Aron, G. Brown, K. Faymon, and S. Levine for their contributions to this paper.

References

1. M. Mirakami, Materials Research Society Spring Meeting, San Francisco, Calif., April 16-21, 1990.

2. J. R. Hull and I. T. Myers, "High Speed Superconductors for Space Power Transmission Lines," Proc. ASME Winter Annual Meeting Conference, San Francisco, Calif., December 10-15, 1989.

3. K. Faymon and S. J. Rudnick, "High Temperature Superconducting Magnetic Energy Storage for Future NASA Missions." Presented at IECEC, 1988.