

Magnesium Diboride (MgB_2) Superconductors for Portable MRIs

Department of Defense Need: A critical factor in the design of future medical equipment for use on or near the battlefield is portability. Medical equipment, in order to be more effectively employed on the battlefield, needs to become increasingly smaller, lighter, simpler, and faster responding. Magnetic Resonance Imaging (MRI) use has increased dramatically in general medicine and is an especially valuable diagnostic tool for battlefield injuries. Current MRI units are unsuitable for battlefield use because they require very low temperature operation and the use of liquid helium, both of which make portability a problem. New technology that could increase portability would be a significant breakthrough, enabling MRI use in ambulances and on the battlefield. Furthermore, helium is a nonrenewable and dwindling resource. Its rapidly increasing cost and decreasing supply are strong commercial drivers that have triggered GE, Philips, and Siemens (three MRI magnet producers that control 95% of the market) to work with Specialty Materials and Hyper Tech Research to develop helium-free technology for MRIs using our magnesium diboride (MgB_2) wire. Government funding will not only accelerate the development of new, portable MRIs but will also ensure that military requirements are met as new machines are developed.



Diagram shows the progression from SMI's boron nanopowder, to Hyper Tech's MgB_2 wire, to the superconducting magnet, to a low cost, light weight MRI scanner

Magnesium Diboride (MgB_2) Superconductors Address Critical Department of Defense Needs:

For portable MRI imaging, the Department of Defense needs a simple, reliable, low-cost superconductor that enables the MRI magnet to operate at temperatures compatible with a portable cryocooler. MgB_2 , a medium temperature superconductor (MTS), can fulfill these critical Department of Defense needs. MgB_2 has advantages over both low temperature superconductors (LTS), and high temperature ceramic superconductors (HTS), as shown below.

- **MgB_2 vs LTS:** LTS systems, the technology presently used in hospital MRIs, operate at very low temperatures and require *non-portable* liquid helium bath cooling. MgB_2 operates at higher temperatures, allowing the use of *portable* cryocoolers, and eliminates the need for a helium bath.
- **MgB_2 vs HTS:** MgB_2 is a simple, low-cost, reliable material. HTS magnets can work at higher temperatures, but are complex multi-layer structures, and very expensive to fabricate; thus a portable MRI magnet made with MgB_2 would be much less expensive than an MRI magnet made with HTS.

Consortium: A consortium led by Specialty Materials (SMI) of Massachusetts and Hyper Tech Research of Ohio is actively developing superconductor wire for next-generation MRIs. SMI and Hyper Tech have worked closely for the past five years to produce demonstration quantities of the best MgB_2 superconductor wires in the world. Further, both companies are working closely with MRI manufacturers (GE, Philips, and Siemens) to provide materials and MgB_2 superconductor wire for future MRI magnets. Other long-standing consortium members include Ohio State University and Ames National Lab at Iowa State University. The U.S. Army's Telemedicine & Advanced Technology Research Center (TATRC) will oversee the program to develop processes and technology necessary to produce MRIs that utilize MgB_2 . TATRC is recruiting additional members from universities, National Labs, wire and component manufacturers, and MRI systems producers.

Project Overview

The objectives of **Magnesium Diboride (MgB₂) Superconductors for Portable MRIs** are to:

- Fast-track nanopowder improvements and process scale-up required to achieve target performance
- Optimize nanopowder conversion process to produce the best formulation of MgB₂ for MRI magnets
- Improve and expand the Hyper Tech processes for the fabrication of MgB₂ superconductor wire
- Incorporate SMI boron nanopowder into Hyper Tech wires and coils ready for magnet and MRI manufacturers to use in full body commercial MRIs and prototype portable superconductor-based MRI systems

FY 2011 Request - \$3.0 Million

Funding Profile (\$ millions)

Fiscal Year	FY11	FY12
Requested funding for Magnesium Diboride (MgB ₂) Superconductors for Portable MRIs	3.0	3.0

Impact

For this initiative and other commercial projects and programs, Specialty Materials Inc. will expand its pilot powder production facility in Lowell, MA and Hyper Tech will expand and improve its Columbus, OH wire production facility. There will be 6 FTEs created in Massachusetts and 4 in Ohio in FY2011, and an additional 10 FTEs in MA and 6 in OH in FY2012.

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