

Potential Aerospace Applications of High Temperature Superconductors

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The recent discovery of High Temperature Superconductors (HTS) with superconducting transition temperature, T_c , above the boiling point of liquid nitrogen has opened the door for using these materials in new and practical applications. These materials have zero resistance to electric current, have the capability of carrying large currents and as such have the potential to be used in high magnetic field applications.

One of the space applications that can use superconductors is electromagnetic launch of payloads to low-earth-orbit. An electromagnetic gun-type launcher can be used in small payload systems that are launched at very high velocity, while sled-type magnetically levitated launcher can be used to launch larger payloads at smaller velocities. Both types of launchers are being studied by NASA and the aerospace industry. The use of superconductors will be essential in any of these types of launchers in order to produce the large magnetic fields required to obtain large thrust forces. Low Temperature Superconductor (LTS) technology is mature enough and can be easily integrated in such systems. As for the HTS, many leading companies are currently producing HTS coils and magnets that potentially can be mass-produced for these launchers. It seems that designing and building a small-scale electromagnetic launcher is the next logical step toward seriously considering this method for launching payloads into low-earth-orbit.

A second potential application is the use of HTS to build sensitive portable devices for the use in Non Destructive Evaluation (NDE). Superconducting QUantum Interference Devices (SQUIDS) are the most sensitive instruments for measuring changes in magnetic flux. By using HTS in SQUIDS, one will be able to design a portable unit that uses liquid nitrogen or a cryocooler pump to explore the use of gradiometers or magnetometers to detect deep cracks or corrosion in structures.

A third use is the replacement of Infra-Red (IR) sensor leads on Earth Orbit Systems (EOS) with HTS leads. IR detectors on these EOS missions are cooled to 4.2K to improve their signal to noise ratio. They are connected to data acquisitions systems using manganin wires (low thermal conductors) to reduce the heat load on the cryogen. Replacing these wires with HTS leads will increase the lifetime of these missions by about 50%. This is a promising application that is ready for actual implementation on such systems. The analysis also show that as the number of IR detectors increase in larger EOS systems, substantial increase in the lifetime of each mission will be realized by using HTS leads instead of the manganin ones.