Cosmic Radiation Effects on High-temperature Superconductors for Deep Space Habitat Shielding

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PROJECT OVERVIEW & TESTING: MATERIALS TECHNOLOGY

- Our experimental study will look at complex materials like YBCO where the crystal structure is integral to its function and study the effects of exposure to various heavy-ion beams with energies more characteristic of actual space radiation (~10 MeV·n⁻¹ to ~10² MeV·n⁻¹) using terrestrial particle accelerators.

- Key materials engineering & technology questions we plan to shed light on are:
  - What materials & thicknesses are required to make an active shielding design possible?
  - What material technology should be applied to HTS tape to mitigate radiation damage and make it work for full and/or repetitive missions, thus extending its life?
  - To do this, we need to better understand how structure changes at necessarily high energies and what the root causes are? What energies cause the biggest problems?
  - We also intend to perform functional testing of a scalable YBCO solenoid while exposed to an operating beam-line (i.e., simulated cosmic radiation exposure) and examine shielding efficiency for alternative magnet geometries

- Material structure will be analyzed before and after irradiation using a Quantum Design Physical Property Measurement System (PPMS®) at Dr. Gupatarama’s laboratory.

- This information will then be used to inform mission designers about superconductor suitability in the space radiation environment and how to design radiation protection for the resultant magnet systems, thus allowing for extended human presence in deep-space.

PROJECT STATUS & FUTURE GOALS

Work on this project has only recently begun. To date we are working on synthesizing HTS YBCO superconductor material in our lab that can be used for preliminary structural and superconducting characterization & analysis. In the near future, YBCO samples grown in our lab will be subjected to low-yield gamma radiation to study the before & after effects of radiation damage on the material. This work will guide us in future experiments, characterization, and analysis involving more expensive 2G YBCO tape and sample irradiation involving particle accelerators, as shown in Figure 11. Preliminary design concepts for experiments that will test functional YBCO solenoids while being subjected to accelerator beams is also being examined.

REFERENCES


ACKNOWLEDGEMENT

We would like to thank Dr. Robert Singleton (NASA, Langley Research Center, VA) and Scott Washburn (University of Colorado, Boulder) for their expertise and guidance on this project.