Radiation Protection of New Lightweight Electromagnetic Interference Shielding Materials Determined

Weight savings as high as 80 percent could be achieved by simply switching from aluminum electromagnetic interference (EMI) shielding covers for spacecraft power systems to EMI covers made from intercalated graphite fiber composites. Because EMI covers typically make up about one-fifth of the power system mass, this change would decrease the mass of a spacecraft power system by more than 15 percent.

Intercalated graphite fibers are made by diffusing guest atoms or molecules, such as bromine, between the carbon planes of the graphite fibers. The resulting bromine-intercalated fibers have mechanical and thermal properties nearly identical to pristine graphite fibers, but their resistivity is lower by a factor of 5, giving them better electrical conductivity than stainless steel and making these composites suitable for EMI shielding.

EMI shields, however, must do more than just shield against EMI. They must also protect electrical components from mechanical, thermal, and radiative disturbances. Intercalated graphite fiber composites have a much higher specific strength than the aluminum they would replace, so achieving sufficient mechanical strength and stiffness would not be difficult. Also, the composites absorb and reradiate electromagnetic radiation in the infrared region, so they are actually considerably better at rejecting heat than the very reflective aluminum covers. What had not been characterized was how well these intercalated graphite fiber composites shielded components from ionizing radiation.

The shielding of high-energy radiation generally increases with the total number of electrons in an atom. Thus, carbon, which has 6 electrons per atom, is a poorer shield than aluminum, which has 13. Intercalation with a few percent of bromine (35 electrons/atom) or iodine (53 electrons/atom) was expected to improve the radiation shielding, though the average number of electrons per atom would still be below that of aluminum. However, the results of tests done at Manchester College, under a cooperative agreement with the NASA Lewis Research Center, indicated a substantial improvement in the radiation shielding--not only by a factor of 8 over the pristine graphite composite, but actually by a factor of 3 over aluminum. Intercalated graphite composites may well be the EMI cover of choice for spacecraft electronics operating in a high-radiation environment.

MASS ABSORPTION OF EMI MATERIALS

Material	46.5-keV gamma-ray, cm^2/g	13.0-keV x-ray, cm^2/g	Ratio of mass abs to mass abs Al
Aluminum	0.34	0.61	1.00
P-100 graphite	0.14	0.25	0.40
P-100 + Br2	0.61	0.96	1.70
P-100 + IBr2	1.00	1.80	3.00