Technology Readiness Level: **5**
Component and/or Breadboard Validation
In Relevant Environment

Eltron Research & Development

Tech Brief

Conductran™

Conductive, Transparent & AO-Resistant Polymide Thin Films

Eltron has developed a polymide film to protect satellite electronics from electrostatic discharge.

Benefits
- Increased resistance to atomic oxygen (AO)
- Electrostatic discharge protection (ESD) built into the matrix
- Additional coatings not required to provide AO and ESD protection

Characteristics
- Film thickness greater than or equal to 1 mil (25 µm)
- Surface resistivity (ohms/square) 10^6-10^{10}
- Volume resistivity (ohms·cm) 10^8-10^{10}
- Tensile strength, ksi (MPa), ASTM D-882-97 14.8 (102)
- Tensile modulus, ksi (GPa), ASTM D-882-97 182 (1.25)
- AO erosion rate (first generation of films) less than 1% the erosion rate for that of Kapton® H at an atomic oxygen fluence of 8.5 x 10^{20} atoms/cm^2 at a mean energy of 4.9-5.0 eV
- Total Mass Loss (TML, ASTM E595-07) = 1.04 % Collected Volatile Condensable Material (CVCM, ASTM E595-07) = 0.02 %
- Water Vapor Recovered (WVR, ASTM E595-07) = 1.04 %

Problem Addressed

Satellites deployed in space are subject to unique design and performance requirements. A major consideration is the constant exposure of the leading edge of the spacecraft to atomic oxygen (AO), vacuum ultraviolet (VUV) radiation and other charged particles.

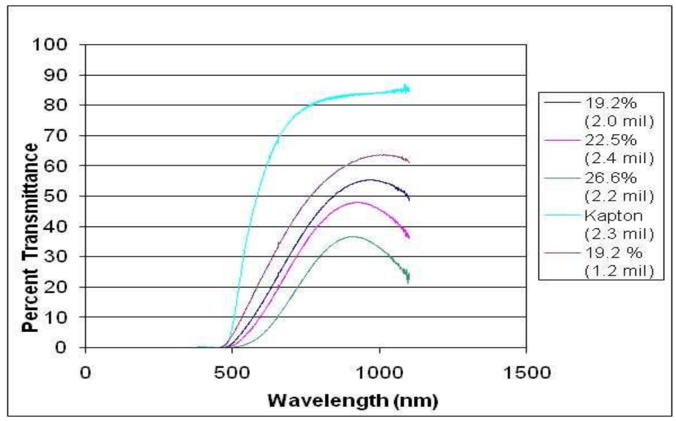

Figure 1. Influence of weight percent conductive additive and thickness on the optical transparency of Conductran™.

Satellites are insulated for thermal control purposes with multilayer insulation (MLI) blankets composed of polymer films. AO erodes the polymers in low Earth orbit (LEO), reducing satellite lifetime. One approach to fighting erosion is to coat the film surface with silicon dioxide (SiO_2). These coatings are inherently more resistant to AO than the polymer. However, because they are very thin (a few nanometers or less), they can be damaged when handled during MLI production, by micrometeoroid debris impacts, and as the result of large temperature changes (-110℃ to +130ºC) which, due to the large coefficient of thermal expansion mismatch, significantly stresses the coating at the interface with the polymer.

Spacecraft charging is also a serious problem. When potential differences on spacecraft surfaces exceed about 500 V, the danger of electrostatic discharge (ESD) exists. Accelerated charge in motion, occurring during an ESD, produces intense electromagnetic pulses which are known to overwhelm and destroy sensitive electronic equipment within spacecraft. ESD protection is currently provided to polymer films by applying a thin coating of Indium Tin Oxide (ITO) to the surface. However, ITO is fragile and may be degraded even with minimal handling. Wiping for cleaning purposes can ruin the surface, as can bending during manufacturing, installation or storage.

Eltron's Solution

Eltron Research & Development and the Air Force Research Laboratory (AFRL) are developing Conductran™, modified polyimide thin films that will overcome the limitations associated with Kapton®, which is used in many MLI blanket designs today. Eltron's polyimide films are loaded with conductive additives, yet still retain satisfactory optical transparency. The polyimide films exhibit surface resistivity suitable for electrostatic discharge (ESD) protection of satellite electronics. The conductive additives are integrated throughout the polyimide matrix, so it cannot be cracked, rubbed off or easily damaged during handling and installation.

The polyimide films display better AO resistance than other commercially available polyimide thin films such as Kapton® or Upilex®. The AO resistance is present throughout the bulk of the polyimide matrix and provides a self-healing feature to the polyimide surface during AO attack or micrometoroid debris impact.

The composite thin films do not require additional coatings for protection from AO or ESD, because these functions are incorporated during film production. The AFRL has already proved the enhanced resistance to AO in previous space flights for the first generation of thin films. The second generation of films is currently being flown on the International Space Station as part of an experimental program to determine their space worthiness.

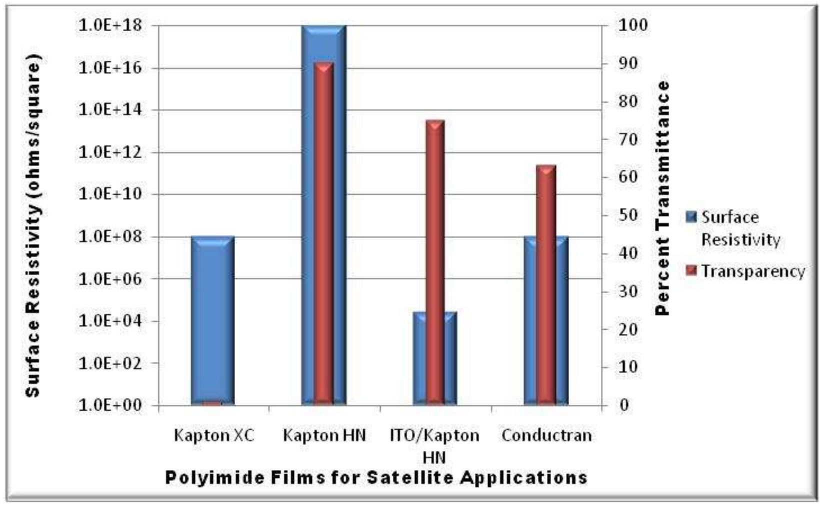

Figure 2. Comparison of the surface resistivity and transparency for commercially available polyimide films to Eltron's newly developed Conductran™.

Figure 1 demonstrates the influence of varying weight percentages of the conductive additive and thickness on the optical transparency of Conductran™ in comparison to Kapton® HN.

The combination of surface resistivity, transparency, AO resistance and durability are unsurpassed by other commercially available polyimide thin films (**Figure 2)**. Kapton® HN displays good transparency but is insulating; carbon black loaded Kapton® exhibits surface resistivity suitable for ESD protection but is completely opaque; ITO coated Kapton® HN has a low surface resistivity and high transparency but is very fragile. Only Conductran™ provides a good combination of all properties in a single polyimide film product.

Stage of Development
Sample quantities of Conductran™ are available upon request. Estimated delivered cost of Conductran tape, 36 inches wide and 12.5 microns thick, $20/ft.

Eltron has a patent pending for this technology.

Contact Us
To discuss the possibility of entering into a business relationship with Eltron, contact the Business Development Group at: business@eltronresearch.com.

Eltron Research & Development

Eltron Research & Development Inc.
Eltron Research & Development commercializes novel technologies involving energy, chemicals, advanced materials and environmental systems.

4600 Nautilus Court South | Boulder, CO 80301 | Phone: 303.530.0263 | www.eltronresearch.com