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ARC TRACK RESISTANT POLYMERS FOR SPACE APPLICATIONS

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TRITON SYSTEMS, INC.

Develops Materials & Process Technologies in:

- **Specialty Materials - Advanced Polymers, Ceramics & MMC's**
- **Scratch Resistant/Antireflective Coatings**
- **Lasers Media - Biomedical Applications**

and Pursues Technology Transfer Through:

- **Joint Development**
- **Licensing**
- **Joint Ventures**

TRITON'S MISSION FOR NASA

ECONOMICALLY COMMERCIALIZE AORIMIDE POLYMERS FOR SPACE, ELECTRICAL AND ELECTRONIC APPLICATIONS

New Electrical Insulation Materials Requirements

- Easily Processed
- Amenable to Scale Up
- Arc Track Resistant
- Atomic Oxygen Resistant
- Light Weight

AORIMIDE * (PAEBI) Is

- Highly Processible
- Can Be Applied as Varnish or Tape
- Exceptionally Resistant to Atomic Oxyegn
- Light Weight (ρ 1.2 g/cc vs 2.1 for Teflon)
- Is Exceptionally Arc Track Resistant

* AORIMIDE is a tradename of a product manufactured by Triton Systems, Inc. Tradenames or manufacturers' names are used in this report for identification only. This usage does not constitute an official endorsement, either expressed or implied, by the National Aeronautics and Space Administration.

PROPERTIES	KAPTON *	FEP TEFLON *	AORIMIDE	Test Method
Tensile strength (ksi) MPa	10 - 25 [1] 70 - 170	2.7 - 3.1 [2] 18 - 21	19-23[6], 20.2[7] 130-160, 139	ASTM D-882
Tensile modulus (ksi) GPa	290 - 450 [1] 2.0 - 3.1	50 [2] 0.34	556[6], 611[7] 3.83, 4.21	ASTM D-882
Initial tear strength g /µm	20.0 [1]		13.6 [7]	ASTM-1004 (JIS C-2318)
Propogated Tear strength g/µm	0.47 [3]			ASTM-1922 (JIS C-2318)
Elongation at break %	70 [1]	250 - 330 [2]	17.8 [6], 16.5 [7]	ASTM D-882
T_g °C.	350-380	275 (T_m) [2]	350 - 375	
CTE	30 - 60 ppm [1]	53-108 ppm [4]	20 - 30 ppm	ASTM D-696
Thermal conductivity @ 23 C W/m K	0.10 - 0.35 [1]	0.25 [2]		ASTM C-177 or ASTM F-433
Dielectric constant @ 1MHz	3.4 [1]	2.10 [4]	2.95 [8]	ASTM D-150
Dielectric strength @ 25µm thick	7000 v/mil (280 kv/mm) [1]	500 - 600 v/mil [2] (1/8 " thick)	7000 v/mil [7]	ASTM D149 (JIS C-2318)
Dissipation Factor @ 1MHz	0.010 [1]	0.0003 [4]	0.0199 [8]	ASTM D-150
Surface resistivity Ω	1×10^{16} [1]		$> 1.0 \times 10^{15}$ [8]	ASTM D-257
Volume Resistivity Ω-cm	1×10^{18} [1]	$> 2 \times 10^{18}$ [4]	$>3.1 \times 10^{15}$ [8]	ASTM D-257
Moisture absorption 24 hrs	0.2 - 2.9 % [1]	< .01 % [2]	2.11% [7]	ASTM D -570
Density (g/cc)	1.42	2.2	1.35	ASTM D-792
A/O resistance	low	good	EXCEPTIONAL	
Resistance to Ultra violet	good [1]	good	EXCELLENT	
Optical	Transparent (brown)	Transparent (clear)	Transparent (yellow)	

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APPROACH

DEVELOP THE INFRASTRUCTURE TO SUPPORT:

- **Synthesis of the Polymer**
- **Processing into Useful Structures**
- **Identify End Applications**
- **Identify Performance Criteria**
- **Develop Prototypes**
- **Characterize Performance**
- **Provide Prototype Parts to End-Users**
- **Commercialize**

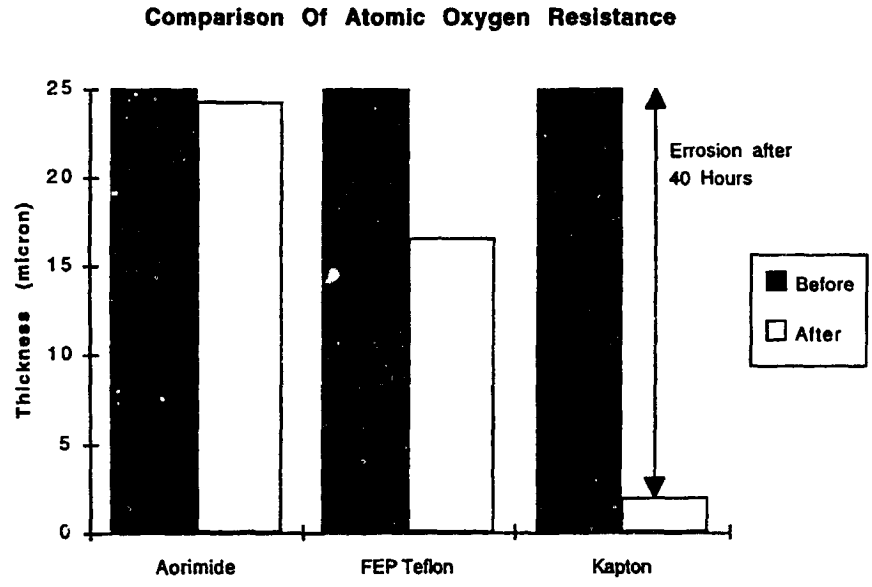
Conclusions on AO Tests on TOR & AORIMIDE Los Alamos, 1993 , and MSFC, 1994

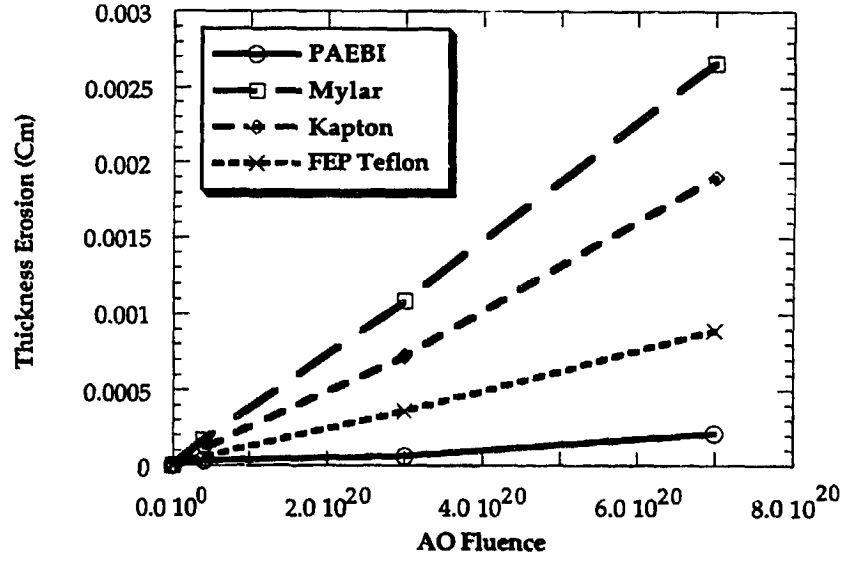
- **Fast AO testing at 10^{21} AO/cm2**

  Aorimide 20 X more AO Resistant than Kapton
  Aorimide 3 X more AO Resistant than Teflon

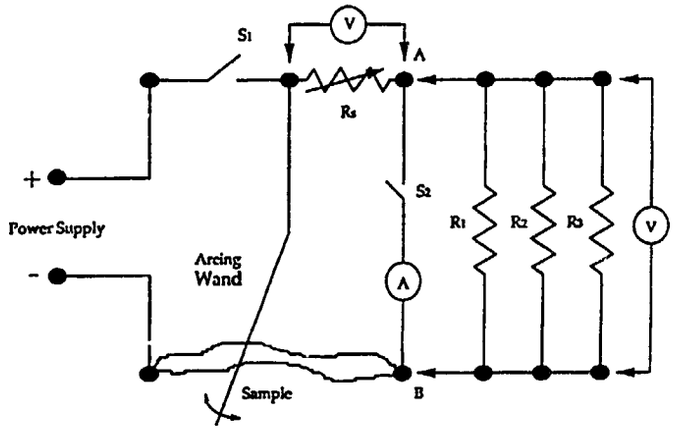
- **Slow Asher Testing at 1.4×10^{21} AOcm2**

  Aorimide > 5 X more AO Resistant than Kapton
  Aorimide not tested versusTeflon


Comparison Of Atomic Oxygen Resistance
Thickness (micron)
25
20
15
10
5
0
Errosion after
40 Hours
Before
After
Aorimide
FEP Teflon
Kapton


Thickness Erosion (Cm)
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
PAEBI
Mylar
Kapton
FEP Teflon
0.0 10^0
2.0 10^20
4.0 10^20
6.0 10^20
8.0 10^20
AO Fluence

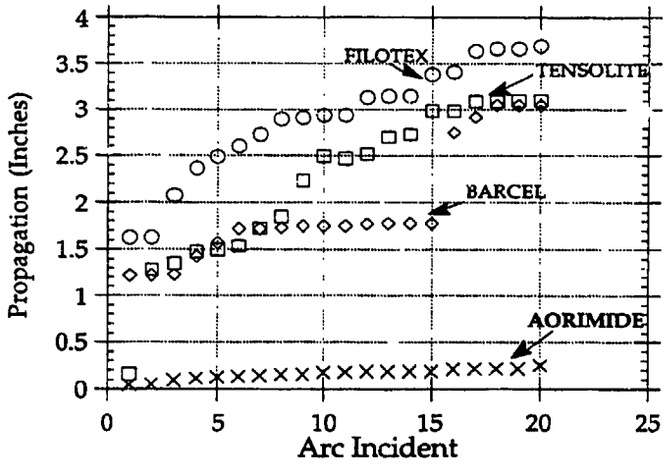
Arc Track Resistance Set-Up

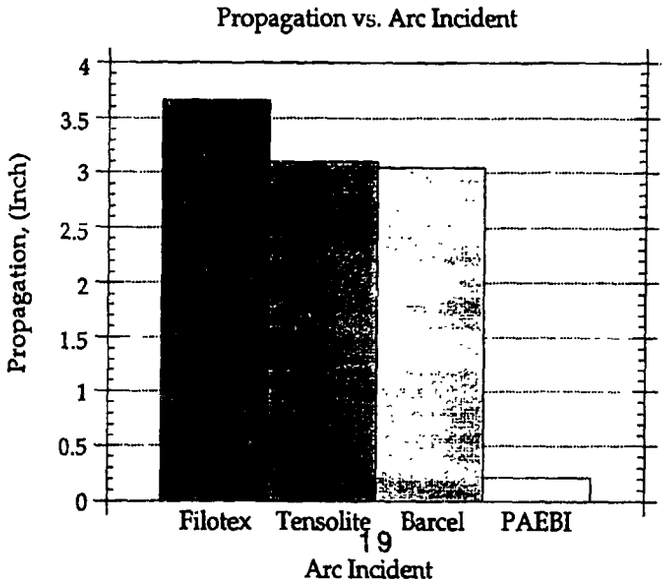


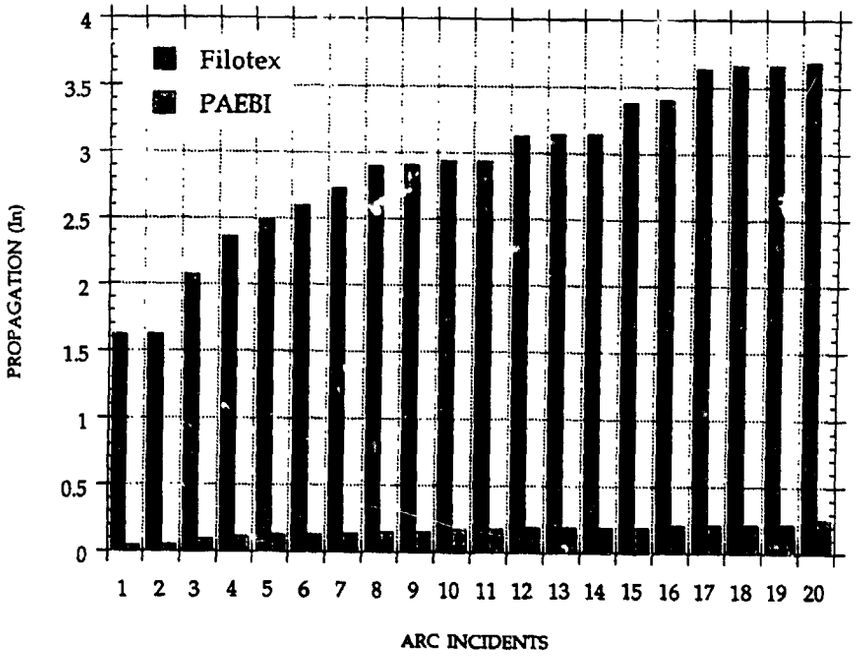
Rs: Series Resistor, 10Ω, 225W

R1, R2, R3: 100Ω, 225W

Power Supply: 0 - 200 VDC, 0 - 17 A, 1000W



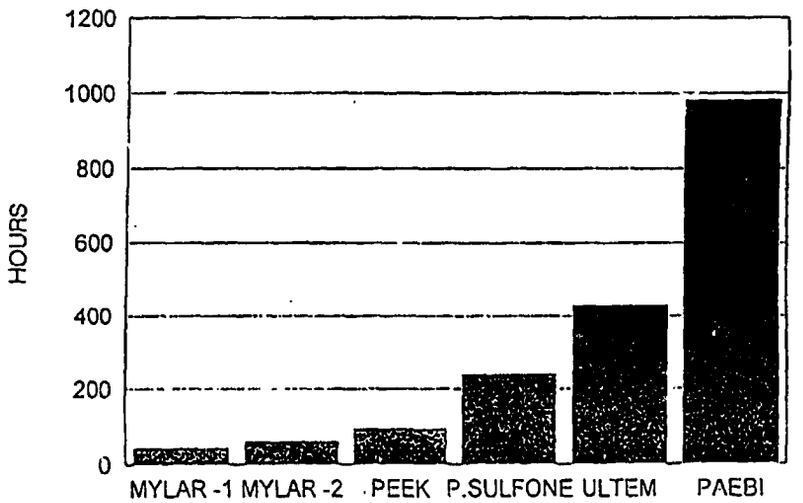

Propagation vs. Arc Incident
Propagation, (Inch)
4
3.5
3
2.5
2
1.5
1
0.5
0
Filotex
Tensolite
Barcel
PAEBI
Arc Incident


Filotex
PAEBI
PROPAGATION (In)
4
3.5
3
2.5
2
1.5
1
0.5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
ARC INCIDENTS

AORIMIDE - The Most Corona Resistant Unfilled Polymer

VOLTAGE ENDURANCE

412 HZ, 3 KV, 1/4" ELCTRS, 10 MIL FILMS



TIME FOR 5TH FAILURE OF 9 POINTS

UPCOMING ACTIVITIES

- **Optimize Wire Coating Application**
- **Verify Test Performance**
- **Coordinate with NASA Missions**
- **Develop Prototypes**
- **Space- Qualify**