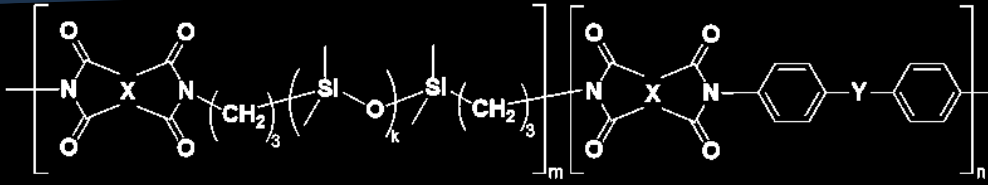


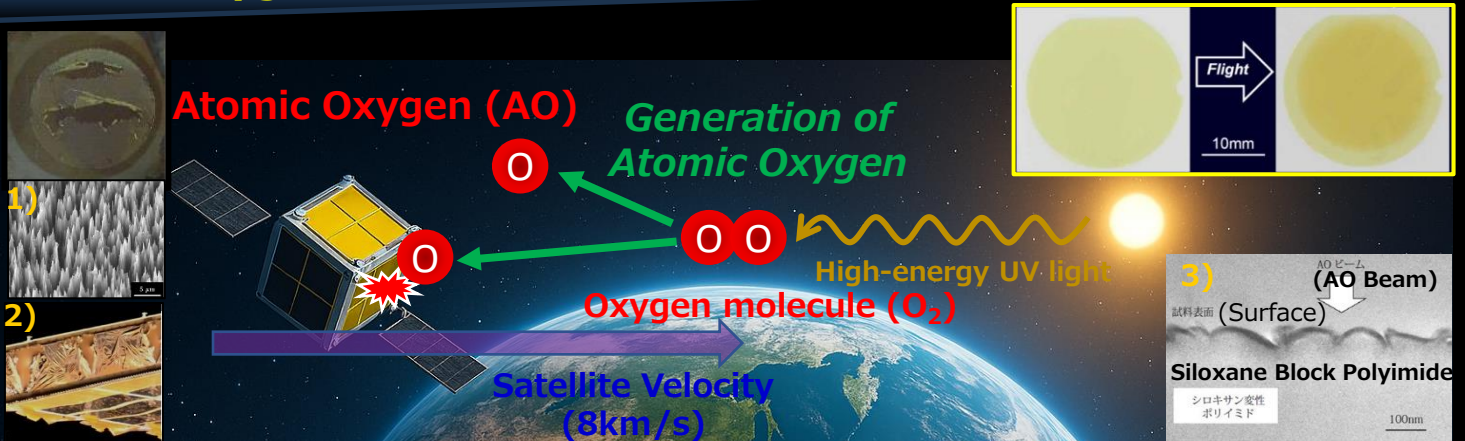
NIPPON STEEL Chemical & Material **ChemMat**

Atomic-Oxygen (ATOX) Tolerant Film “Siloxane Block Polyimide BSF series” for Low and Very Low Earth Orbit Satellite

BSF Series Typical Molecular Structure

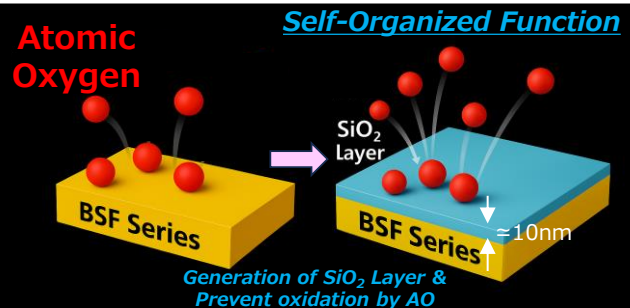
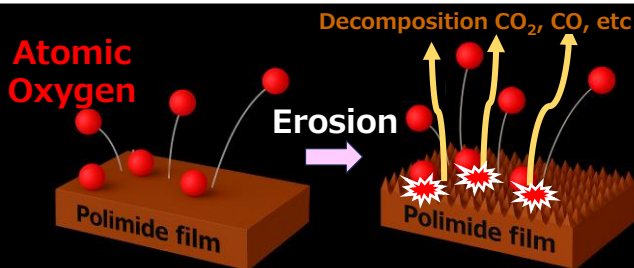


Atomic-Oxygen Tolerant Mechanism



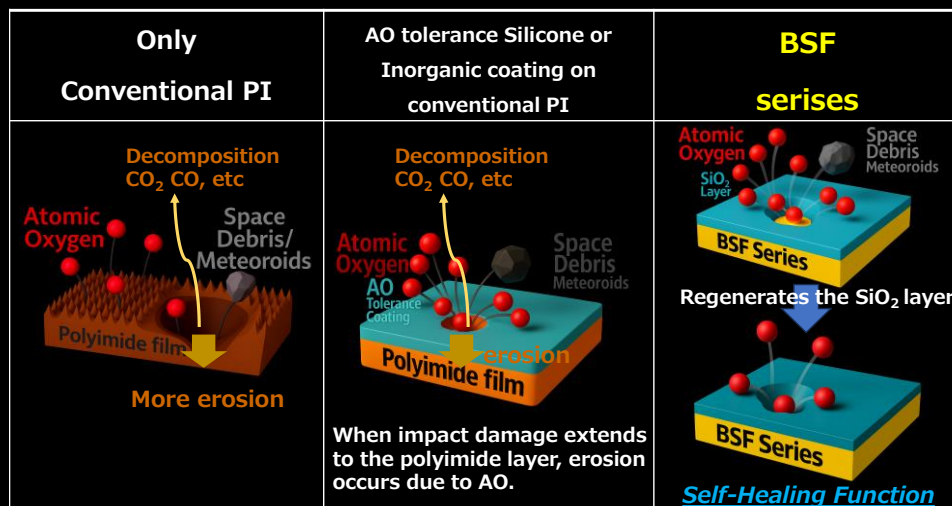
The case of typical polyimide used on the satellite

The case of BSF series used on the satellite



- 1) H. Shimamura, T. Nakamura, Mechanical properties degradation of polyimide films irradiated by atomic oxygen, Degradation and Stability Volume 94, Issue 9, September 2009
- 2) B. A. Banks et al., "Issues and Consequences of Atomic Oxygen Undercutting of Protected Polymers in Low Earth Orbit," NASA/TM-2002-211577, 2002
- 3) MATERIAL STAGE Vol.10, No.10 2011

Self-Healing Function of BSF series



Low & Very Low Earth Orbit Exposure Tests by JAXA



© JAXA

2009 ISS "KIBO"
JEM/MPAC & SEED
(8.5months)



© JAXA

2012-2015 "SDS-4"
Thermal control material
demonstration experiment



© JAXA, NASA

2015-2016
"ExHAM"



© JAXA

2017-2019 "SLATS"
Exposure testing of materials
in very-low earth orbit
(altitude : 160km)

Application Example

- ★ Multi-layer insulation (MLI)
- ★ Substrate of Solar Panel
- ★ For anti-debris & deorbit of Satellite

Adapted Product

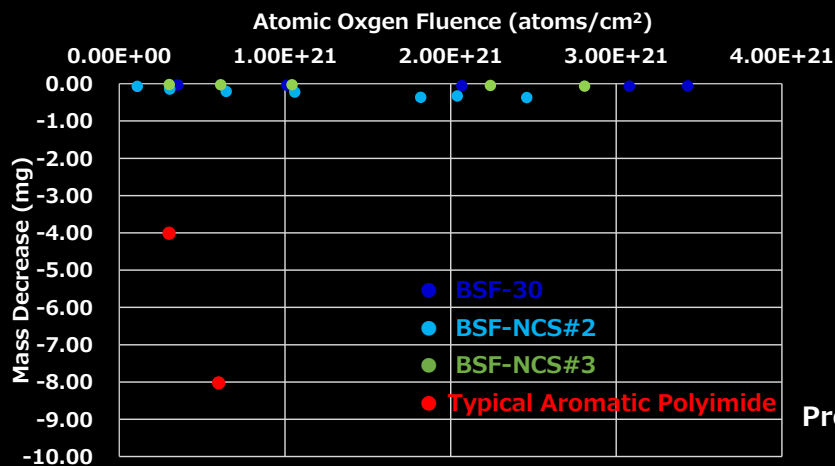


Drag Sail

© Axelspace

Atomic-Oxygen Tolerant Test Results

Results of mass change of PI by AO irradiation



Provided by JAXA

Typical Properties of BSF series

Item	unit	BSF-30	BSF-NCS#2	BSF-NCS#3
Glass transition temp (Tg)	°C	187	176	140
5% Thermal decomposition (Td5)	°C	456	462	456
coefficient of thermal expansion(CTE)	ppm/K	100	68	92
Young's Modulus	GPa	1.4	1.9	1.7
Elongation	%	15	11	45
Tensile Strength	MPa	53	87	59
Cyclic siloxane Outgassing components	—	Contain (D10-D17)	None	None