

Very Large, Thin Polyimide Film/Al Solar Sail Spacecraft

— Design and Fabrication —

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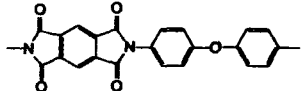
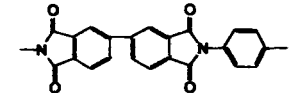
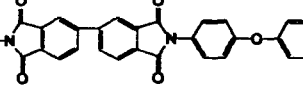
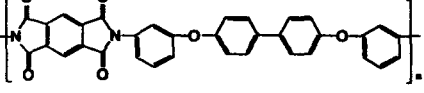
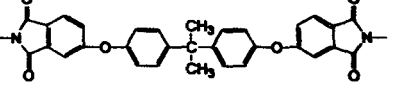
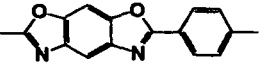
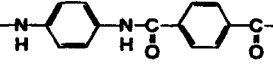
Introduction

Since Fridrikh proposed the concept of solar sail spacecraft obtained by reflecting sunlight off of a large, a very thin, metalized polymer film, the long time has passed. The most basic technological developments for structural design of the sail are the sealing, fabricating, packaging, and deployment. In addition to the space environmental stability of the sail material, there are many difficulties as follows.

1. A very thin, high performance films have to be manufactured in relatively wide strip (100-150 cm width).
2. The sealing for a high glass transition temperature (T_g) thin film and a large sail fabrication have to be developed with the sail configuration.

This paper discussed the feasibility on the materials and the sealing, fabricating, and packaging.

Commercially available polyimide films : Chemical structures and properties

Polyimide	Structure	Film thickness (μm)	T_g ($^{\circ}\text{C}$)	Modulus (GPa)	Elongation at break (%)	Environmental stability		Sealing by heat
						UV	Radiation	
APICAL (KAPTON)		~7.5	420	3.0	~50	○	○	×
UPILEX-S		~7.5	360	9.0	30	○	○	×
UPILEX-R		(7.5)	300	3.0	100	○	○	△
AURAM		25	250 (T_m :380)	3.0	90	○	○	○
ULTEM		12.5	218	3.0	60		△	○
ZYLON (PBO)		△	?	(10.0)		△	○	×
ARAMICA (ARAMID)		2.5	?	15.0	20	△	△	×

Feasibility study on various sealing methods of thin films for solar sail

Case 1. A high Tg polyimide film with a low Tg polymer on the surface layer for heat sealing

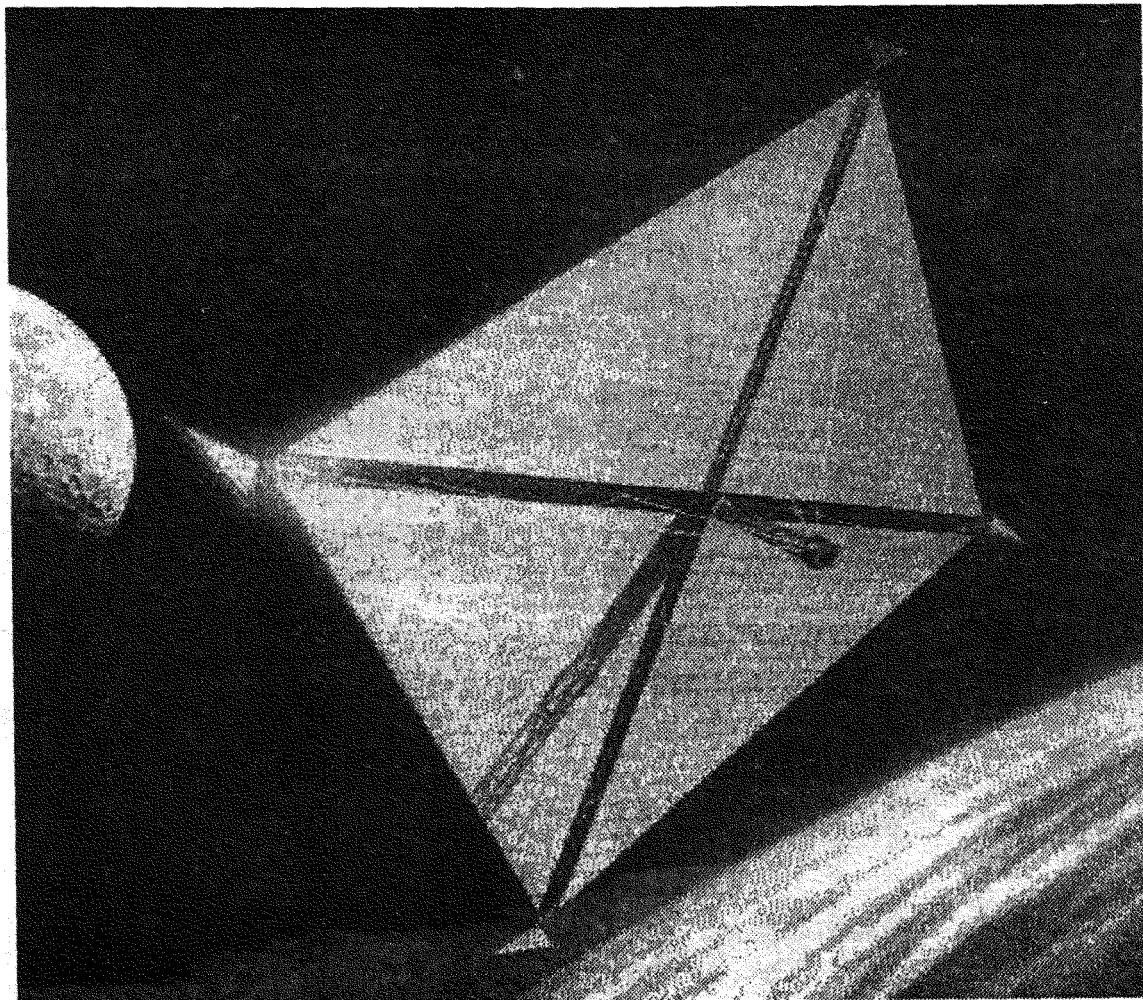
Requirement : Development of the coating technology and of the sealing machine
Environmental stability (heat, radiation and UV etc)

Case 2. Thermo-plastic polyimide with relatively low Tg

Requirement : Evaluation of space environmental stability
Screening the sealing conditions such as temperature, pressure, time, etc.

Case 3. Sealing by using an adhesive tape

Requirement : Creep deformation of the adhesive layer, out gases, and evaluation of space environmental stability



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