Atomic Oxygen Resistant Co-polyimides containing phenylphosphine oxide

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Aromatic polymers containing phenylphosphine oxide (PPO) groups, which possess good flame-Retardant property, excellent thermal stability and high glass transition temperature (Tg), have been considered as the important candidates for cell blanket and thermal blanket used in aerospace technology. There have been many studies focused on this field in last decade. Therein, modification of high performance polymers with PPO has be attracted much attention in order to satisfy the environment at low earth orbit (LEO), such as atomic oxygen (AO) and ultraviolet rays (UV) resistance etc.[1-3]

In this report, a new compound containing PPO group, bis(3-aminophenoxy-4'-phenyl)phenylphosphine oxide (m-BAPPO), was designed and synthesized successfully. And then, a series co-polyimide films were prepared from m-BAPPO, 4.4'-Diaminodiphenylethe (4,4'-ODA) and 3,3',4,4'-Biphenyl tetracarboxylic dianhydride (s-BPDA) by two-step random polymerization in polar solvent with keeping the stoichiometric of diamine and dianhydride equal and changing the proportion of the two diamines. The films were cast from PAA solution onto the flat glass plate, heated in a forced oven making them dry and then treated at 200^{O}C 1hour, and 300 ^{O}C 1hour in a vacuum oven to get some light-color, flexible polyimide materials.

The basic properties data of the co-polyimide films were shown in Table 1. It was found that the co-polyimide films retained the good mechanical properties and thermal stability, in spite of the fact that they reduce with the increase of content of m-BAPPO. Furthermore, the films had high and similar transmittances at 500nm ranging in 78.6% to 80.7%, but the transparency onset wavelength (λ_o) decreased from 421nm to 394nm with the increase of the diamine containing phosphine. The optical properties of co-polyimide films showed much more excellent compare with Kapton® HN film.

Table 1. Data of the Co-Polyimide Films

Samples	Strength (MP)	Modulus (GP)	Elong (%)	Tg (℃)	Td_5 (℃)		λ_o (nm)	T% (at 500nm)
					Air	N_2		
80%*	2.7	113	7	256	501	531	394	79.5
60%	2.5	119	11	262	502	527	393	80.0
40%	3.0	133	9	270	509	542	407	80.0
20%	2.8	124	13	280	546	563	411	78.6
0%	3.4	165	36	289	560	573	421	80.7
Kapton	2.5	231	72	385	-	-	441	45.5

* 80% means the stoichiometric content of m-BAPPO in diamine is 80%

Atomic oxygen (AO) exposure experiments were conducted in a ground-based AO effects simulation facility on the co-polyimide films compare with Kapton® HN film sample, which a typical materials used in aerospace technology[6]. The variation curves of mass loss percentage and erosion yield along with AO exposure fluence were shown in Figure 1 and Figure 2, respectively. After a 32hours atomic oxygen exposure experiment (Fluence=8.75×10^{20}atoms/cm^2), it was found that the mass loss of the co-polyimide films decreased from 3.29mg/cm^2 to 0.85 mg/cm^2 with the increase of content of PPO group, and that of the 80% co-polyimide sample was even less than a quarter of Kapton sample. The Erosion yield also decreased as the addition of the PPO group, it was only 23-45% as low as that of

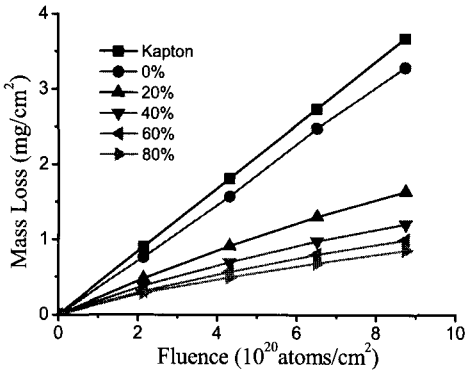

Figure 1. Mass loss of the co-polyimide films

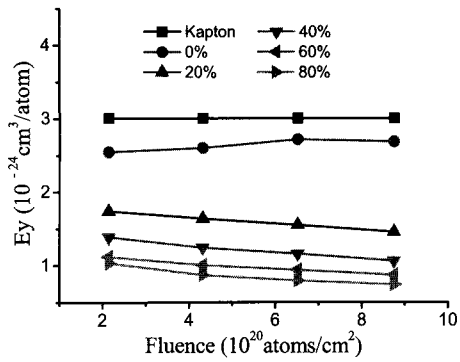

Figure 2. Erosion yield of the co-polyimide films

Kapton, and decreased with the experiment process. The SEM images of the surface the samples after AO exposure experiments were shown in Figure 3. It was found that the gully Eroded by AO more and more smaller as the increase of PPO group. So, all of above proved that the PPO group greatly improved the AO resistant performance of the co-polyimide films. The co-polyimide containing phenylphosphine oxide were expected to be a candidate material applied in low earth orbit.

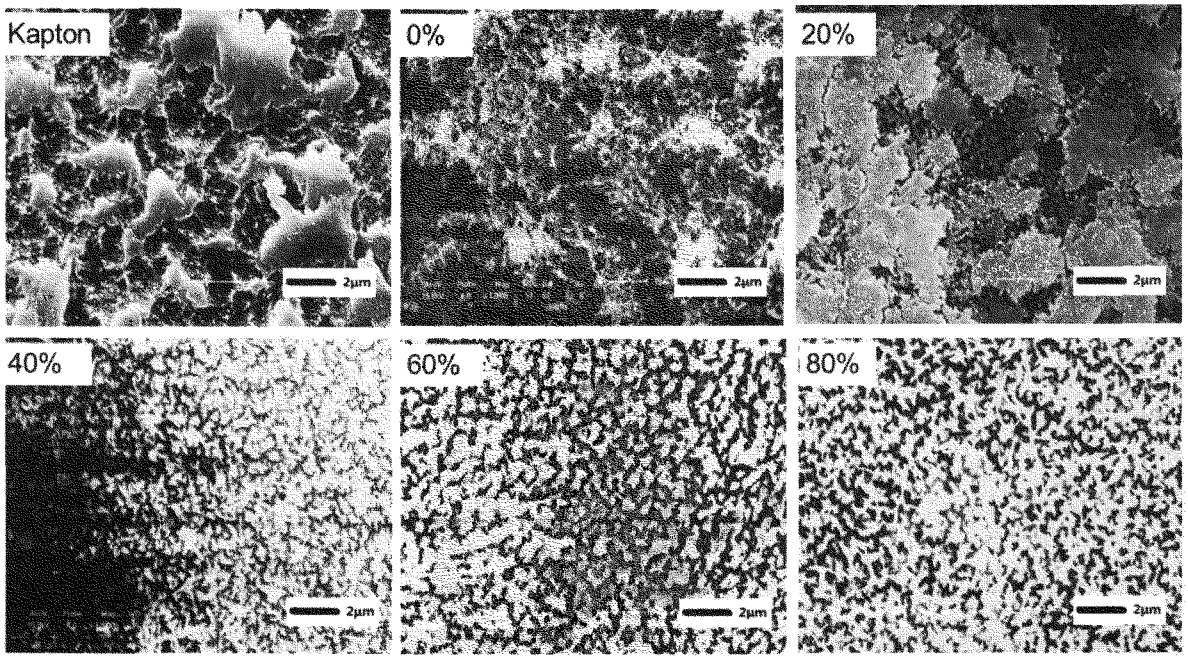

Figure 3. SEM images of the surface of the samples after AO exposure experiments

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