Polyimides--Promising Polymer Materials

Group number: P26

Group members: Qi You, Qier Lei

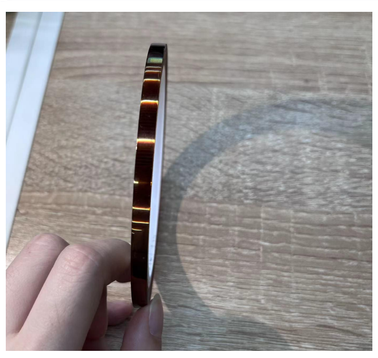

Figure 1: Physical image of polyimide tapes.

Abstract

Polyimide (PI), containing the imide ring (-CO-NR-CO-) on the main chain, is categorised as high temperature engineering polymer. Polyimides exhibit an exceptional combination of thermal stability, mechanical toughness, and chemical resistance. As a special engineering material, it has been widely used in aviation, aerospace, microelectronics, nano, separation film and other fields. In this poster, we present the high-quality properties and application aspects of polyimide.

Key words：polyimide，thermal stability，electromagnetic shielding，separation film

Literature Review

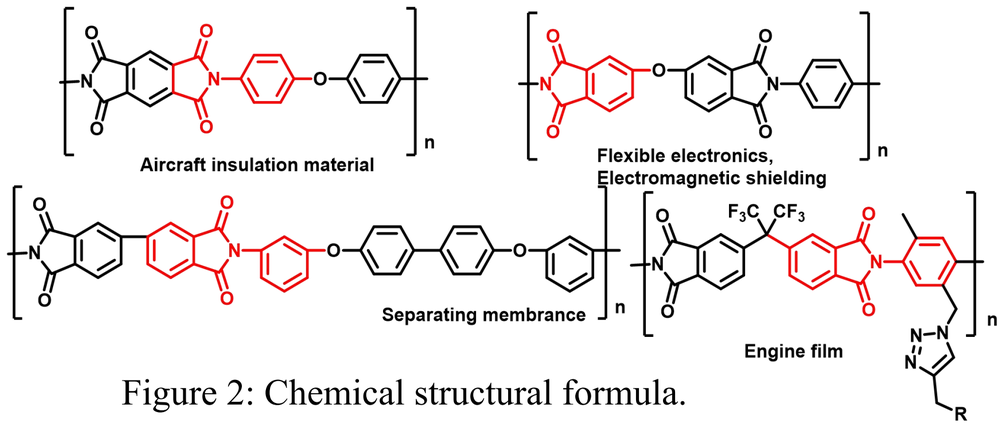

Figure 2: Chemical structural formula.

The **history** of polyimide shows in figure 3.[1].

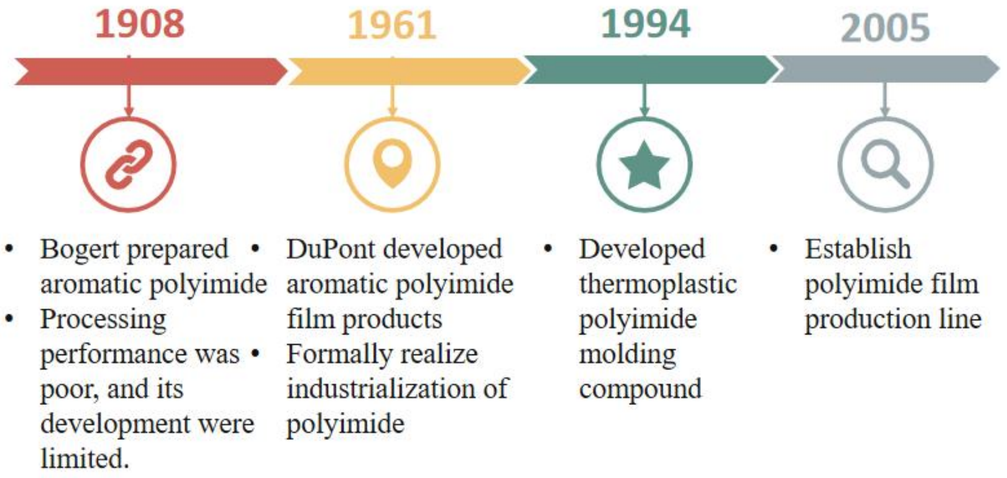

Figure 3: History and development of polyimide.

Polyimides (PI) are high-performance polymers of imide monomers which contain two acyl groups (C=O) bonded to nitrogen (N)[2]. Polyimide can be **synthesized** by polycondensation of dianhydride monomer and diamine monomer in aprotic polar solvent at low temperature, and then dehydration cyclization at high temperature or chemical imimization by adding anhydride dehydrating agent and amine catalyst[3].

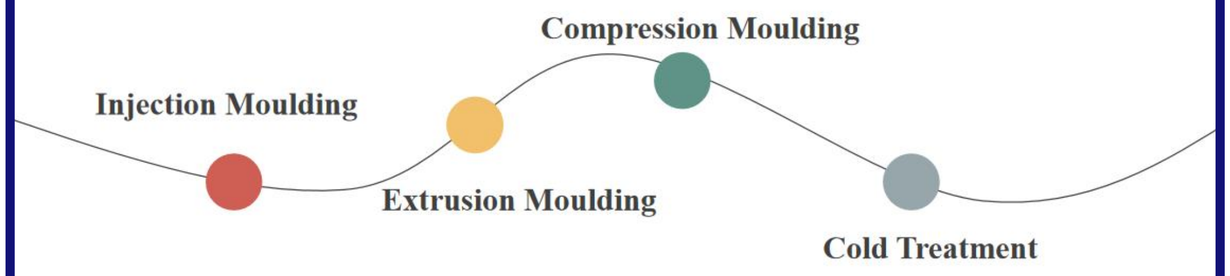

Figure 4: Manufacture processes of polyimide.

Through injection molding, extrusion molding and other **manufacture** processes to afford different shapes of materials, to meet the film, layer and other fields of application[4].

Polyimide has advantages of excellent **characteristics** so that has a widely **use**.

Properties

The properties of different polyimides often depend on the properties of different monomers. It has excellent heat resistance, low temperature resistance, mechanical properties, dielectric properties and high radiation resistance characteristics.

General properties		**Electrical properties**	
Density	1.43-1.59	Dielectric loss	10^（-3）
Price	600K-3000K RMB\ton	Volume resistance	1017Ω\cm
Mechanical properties		**Solubility**	
Young's modulus	3-4Gpa	Insoluble in organic solvents and diluted acids	
Tensile strength	>100Mpa	**Stability and reactivity**	
Thermal properties		Hydrolyzability	
Thermal expansivity	2*10^（-5）-3*10^（-5）	Radiation resistance	
High temperature resistance	>500℃	Perishable	
Low temperature resistance	<-269℃	**Toxicological**	No
Operating temperature	(-200)℃-300℃	**Storage and transport**	
Electrical properties		Temperature	10-30℃
Dielectric constant	3.4	Humidity	40-70%
Dielectric strength	100-300KV\mm	Avoid exposing to direct sunlight	

Table 1[1]: Properties about polyimides.

Application

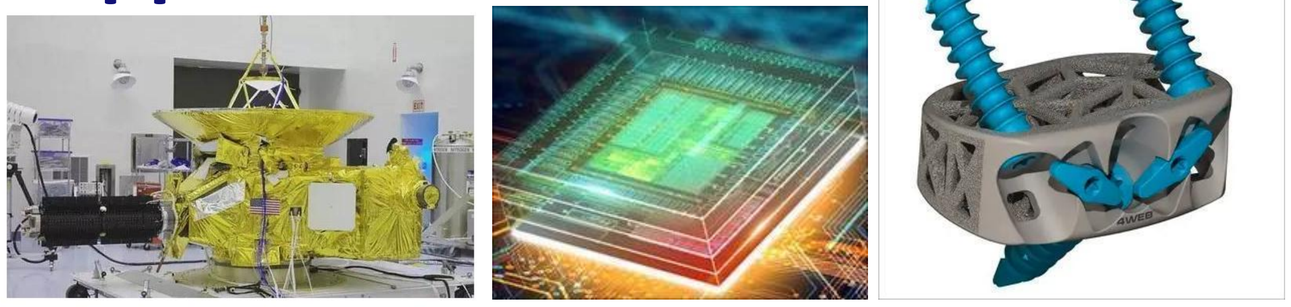

Figure 5： Polyimides are used in spacecraft, photoresist, artificial bone.

Polyimide is often used in aerospace, electronic communication, medical power and other fields because of its good properties[6]. Polyimide can be a high-quality material for spacecraft and rocket components for its heat resistance, such as the more than 50% of the American supersonic aircraft[5].

Safety assessment

Toxic-- raw materials; molding process(hydrolysis); deteriorate.

Processing--skin burns(welding); scratched fingers(cutting)

Safeguard Procedures →

- Wear a laboratory protective mask
- Properly wearing lab clothing
- Wear gloves and glasses throughout the experiment

Reference

[1]ChemicalBook. High performance material -- polyimide [Internet]. ChemicalBook. 2019.
[2]Omnexus. Polyimide (PI) [Internet]. Uses, Structure, Properties & Applications.
[3] DING MENG XIAN Polyimides: Chemistry & Structure-property Relationships – Literature Review 1.1 Introduction
[4]Ni H jiang, Liu J gang, Wang Zhe, Yang S yong. A review on colorless and optically transparent polyimide films: Chemistry, process and engineering applications. Journal of Industrial and Engineering Chemistry. 2015;28(1226-086X):16–27.
[5]Sciencedirect. Polyimide - an overview [Internet]. ScienceDirect Topics. 2020.
[6]Dong Y, Dong X, Zhu D, Yang Y, Luo C, Li Y, et al. Development and application prospect of polyimide. Chinese plastics. 2022;36(09).