Thermally Stable Polyimides

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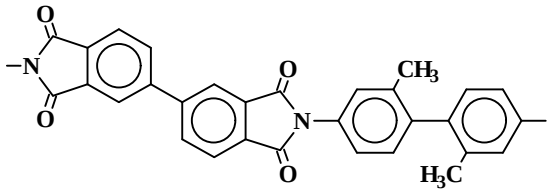
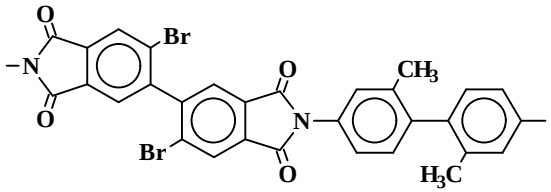
Research Objective: Molecular architectures of polyimides have been designed to achieve high thermal stability of the polymers for aircraft interior applications

Approach: Both novel aromatic dianhydrides and diamines have been designed. Eight new dianhydrides of specific molecular architecture have been synthesized based on 2,2′-disubstituted 4,4',5,5'-biphenyltetracarboxylic dianhydrides (2,2′-disubstituted BPDAs). A series of twelve aromatic diamines, 4,4'-diamino-2,2'-disubstitutedbiphenyls, has also been synthesized. Polyimides made by these dianhydrides and diamines should exhibit high thermal and thermo-oxidative stability and high char yield.

Accomplishment Description: The following aromatic polyimides have been synthesized (only the DMB series is listed)



BPDA-DMB



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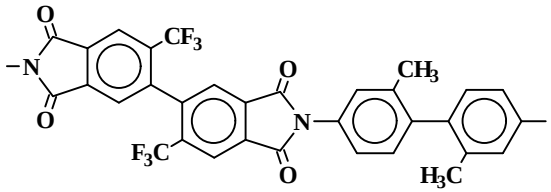

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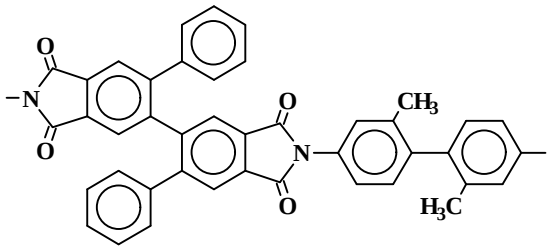

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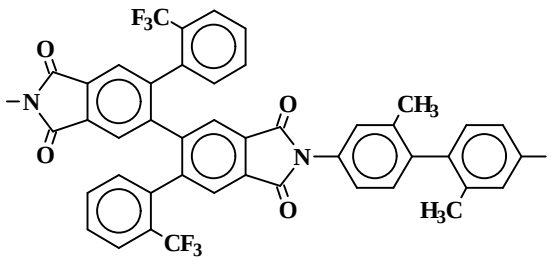

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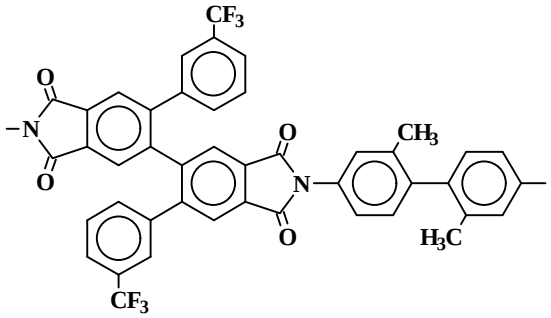

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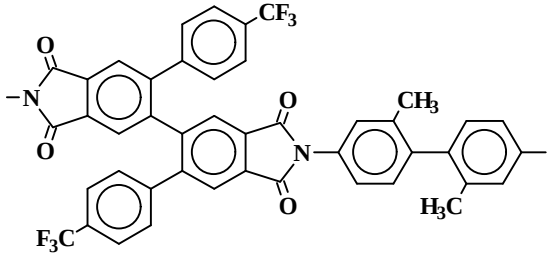
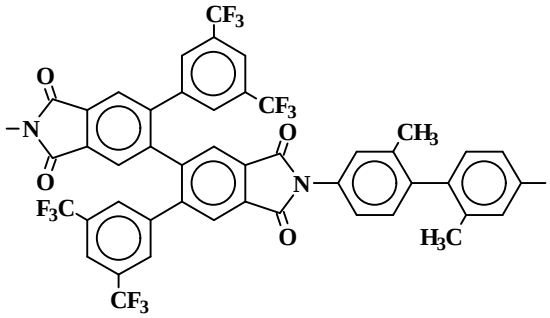
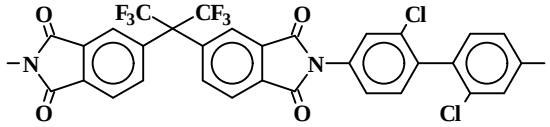


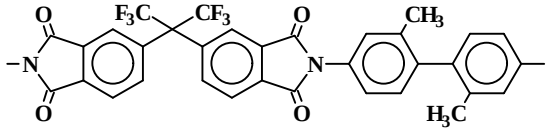
P6FDPBPDA-DMB



M12FDPBPDA-DMB



6FDA-DCB



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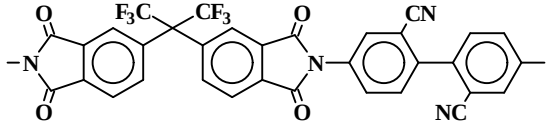

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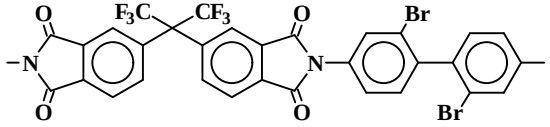

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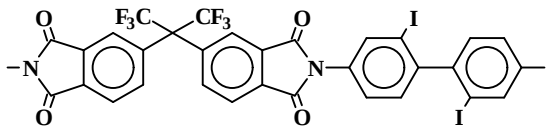
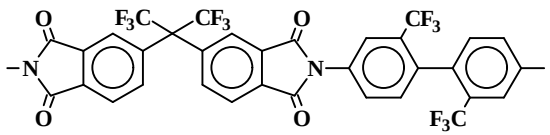
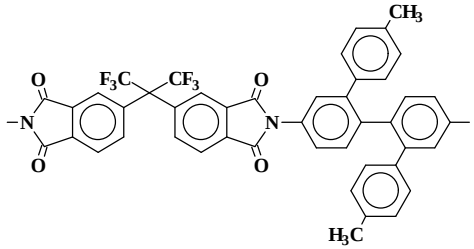


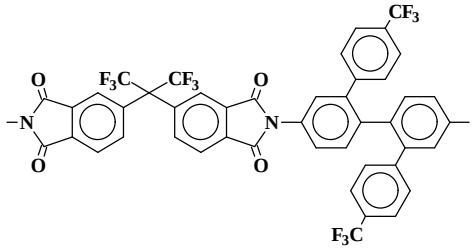
6FDA-DIB



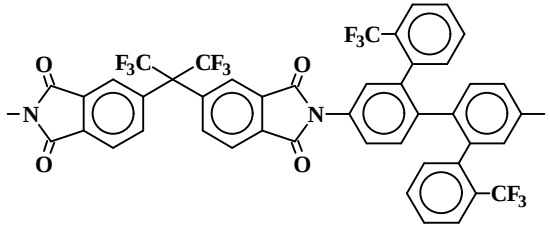
6FDA-PFMB



6FDA-MPPBZ



6FDA-P6FDPBZ



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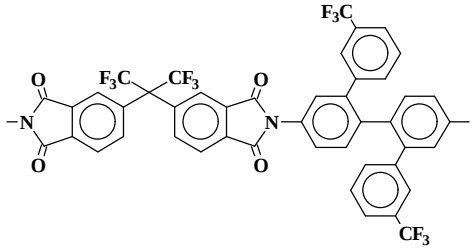

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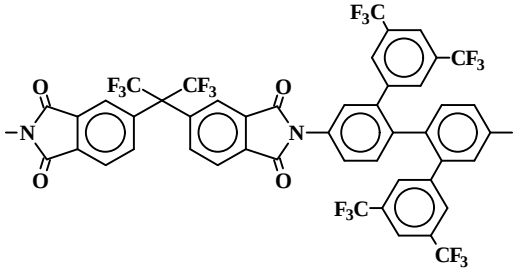
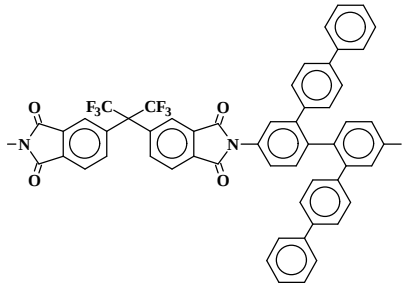


6FDA-M12FDPBZ



6FDA-3PBZ

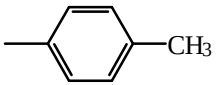
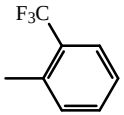
Their thermal and thermo-oxidative stability has been examine using TGA in both dry nitrogen and air atmospheres. The results are listed as follows:

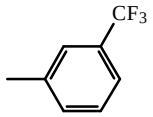
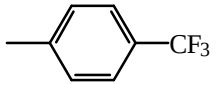
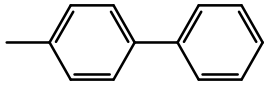
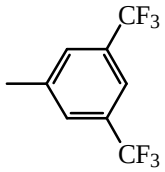
Table 1. Temperatures for 2% and 5% weight loss in air and nitrogen for PFMB- and DMB-based polyimides with different dianhydrides

Dianhydride	TGA (Air)* (°C) 2%/5%(wt)	TGA (N_2)* (°C) 2%/5%(wt)	TGA (Air)** (°C) 2%/5%(wt)	TGA (N_2)** (°C) 2%/5%(wt)
BPDA	531/564	530/565	468/509	489/515
DBBPDA	486/518	492/523	412/441	437/458
HFBPDA	530/549	537/566	464/498	460/503
DPBPDA	498/539	513/542	427/508	479/511
O6FDPBPDA	529/553	531/559	439/495	481/509
M6FDPBPDA	529/563	536/566	433/509	485/512
P6FDPBPDA	524/546	534/555	440/502	484/510
M12FDPBPDA	530/550	535/565	440/495	480/513

* PFMB-based polyimides
** DMB-based polyimides

Table 2. Temperatures for 2% and 5% weight loss in air and nitrogen for 6FDA-based polyimides with different diamines

Diamine	2,2′-Disubstituted Groups	TGA (Air) (°C) 2%/5%(wt)	TGA (N_2) (°C) 2%/5%(wt)
DCB	—Cl	458/497	486/513
DMB	—CH_3	480/503	488/505
DCN	—CN	475/513	500/528
DBB	—Br	434/472	457/504
DIB	—I	341/413	375/467
PFMB	—CF_3	490/518	505/530
MPPBZ		425/471	440/480
O6FDPBZ		493/517	507/523

M6FDPBZ		488/508	506/525
P6FDPBZ		487/513	506/523
3PBZ		485/513	501/521
M12FDPBZ		482/509	505/525

Significance: All of the aromatic polyimides are newly designed and synthesized. These polyimides are organo-soluble and relatively easy to be processed. They may potentially commercializable for certain applications.

Reference: F. Li, L. Huang, Y. Shi, X. Jin, Z. Wu, Z. Shen, K. Chuang, R.E. Lyon, F.W. Harris, amd S.Z.D. Cheng, *Thermal Degradation Mechanism and Thermal Mechanical Properties of Two High-Performance Aromatic Polyimide Fibers*, J. Macromol. Sci.- Part B. Phys.,**38**(1&2), 107-122 (1999)

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