

## Optically Active and Organosoluble Poly(amide-imide)s Derived from *N,N'*-(Pyromellitoyl)bis-L-histidine and Various Diamines: Synthesis and Characterization

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**Abstract:** An optically active diacid containing the L-histidine moiety was prepared by reacting pyromellitic dianhydride (1,2,4,5-benzenetetracarboxylic acid 1,2,4,5-dianhydride) **1** with L-histidine **2** in acetic acid, and was polymerized with several aromatic diamines **5a-g** to obtain a new series of optically active poly(amide-imide)s (PAIs) using two different methods, such as direct polycondensation in a medium consisting of *N*-methyl-2-pyrrolidone (NMP)/triphenyl phosphite (TPP)/calcium chloride (CaCl<sub>2</sub>)/pyridine (Py) and direct polycondensation in a tosyl chloride (TsCl)/pyridine (Py)/*N,N*-dimethylformamide (DMF) system as a condensation agent. The resulting new polymers **6a-g** with inherent viscosity was obtained in good yield. The polymers were readily soluble in polar organic solvents, such as *N,N*-dimethylacetamide (DMAc), *N,N*-dimethylformamide (DMF), and dimethyl sulfoxide (DMSO). The obtained polymers were characterized by FTIR, specific rotation, elemental analysis as well as <sup>1</sup>H-NMR spectroscopy and gel permeation chromatography (GPC). The thermal stability of the resulting PAIs was evaluated with thermogravimetric analysis techniques under a nitrogen atmosphere.

**Keywords:** poly(amide-imide)s, thermally stable, optically active polymers, imidazole.

### Introduction

Aromatic polyamides, polyimides, poly(amide-imide)s, polybenzazoles and other heterocyclic polymers are well known as high-performance polymer materials for their excellent mechanical and electrical properties, high thermal stability and chemical resistance as well as their high strength and high modulus as fibers. The peculiar specificity of these wormlike polymers is rather high equilibrium rigidity of the chains, which is determined by original structure of the macromolecules. Therefore, supra-molecular structure and mechanical properties of the polymers are mainly provided by extended conformation of the individual macromolecules.<sup>1-7</sup> However, the main drawbacks of these classes of aromatic polymers are their insolubility and high glass transition temperature that cause difficulties in both synthesis and processing.<sup>8,9</sup> Therefore, several approaches have been made through synthetic modification by the incorporation of flexible linkages<sup>10</sup> and bulky pendant groups.<sup>11</sup> Poly(amide-imide)s are one of the important copolymers that show good balance between processability and thermal stability.<sup>12-15</sup>

The synthesis and application of chiral polymers is of particular interest from the viewpoint of material science and newly considered topics. Chiral polymers have found suc-

cessful uses in chromatographic separation of enantiomers, chiral liquid crystals, nonlinear optical devices, optical switches, biomedical devices, etc.<sup>16-20</sup> A direct and effective way for synthesizing chiral polymers is to introduce chiral elements into the polymer backbone or side chains. The combination of PAIs with chiral elements is of synthetic interest and also may lead to chiral recognition membranes.<sup>21</sup>

As specific properties should be expected from the resulting polymers, the introduction of imidazole units in macromolecular chains has attracted the attention of chemists for long time. One of the pioneering works related to this subject was reported in 1967, Krieg and Manecke.<sup>22</sup> Imidazole rings in these polymers possesses both proton-donor (-NH-) and proton-acceptor (-N=) hydrogen bonding sites that exhibit specific interactions with polar solvents<sup>23-25</sup> and it forms miscible blends with a variety of polymers.<sup>26-30</sup>

In this article, synthesis and characterization a series of new poly(amide-imide)s **6a-g** containing imidazole rings as a pendant groups from the direct polycondensation reaction of *N,N'*-(pyromellitoyl)bis-L-histidine **4** with seven aromatic diamine such as 4,4'-diaminodiphenylether **5a**, 4,4'-diaminodiphenylsulfone **5b**, 3,3'-diaminodiphenylsulfone **5c**, 4,4'-diaminobenzidin **5d**, 1,4-phenylenediamine **5e**, 1,3-phenylenediamine **5f** and 1,5-naphthalenediamine **5g** by two different methods.

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## Experimental

**Materials.** pyromellitic dianhydride (1,2,4,5-benzenetetracarboxylic acid-1,2,4,5-dianhydride) **1**, L-histidine **2**, 4,4'-diaminodiphenylether **5a**, 4,4'-diaminodiphenylsulfone **5b**, 3,3'-diaminodiphenylsulfone **5c**, 4,4'-diaminobenzidine **5d**, 1,4-phenylenediamine **5e**, 1,3-phenylenediamine **5f**, 1,5-naphthalenediamine **5g** (from Merck) and tosyl chloride (TsCl; from Merck) were used without further purification. Solvent: *N*-methyl-2-pyrrolidone (NMP; from Fluka), *N,N*-dimethylformamide (DMF; from Merck), pyridine (from Acros), triphenyl phosphite (TPP; from Merck) were used as received. Commercially available calcium chloride (CaCl<sub>2</sub>; from Merck) was dried under vacuum at 150 °C for 6 h.

**Apparatus and Techniques.** <sup>1</sup>H NMR and <sup>13</sup>C NMR spectra were recorded on a Bruker 300 MHz instrument (Germany). Fourier transform infrared (FTIR) spectra were recorded on Galaxy series FTIR 5000 spectrophotometer (England). Spectra of solid were performed by using KBr pellets. Vibration transition frequencies were reported in wavenumber (cm<sup>-1</sup>). Band intensities were assigned as weak (w), medium (m), shoulder (sh), strong (s) and broad (br). Inherent viscosities were measured by a standard procedure by using a Technico Regd Trad Mark Viscometer. Specific Rotations were measured by an A-Kruss polarimeter. Weight-average ( $\bar{M}_w$ ) and number-average ( $\bar{M}_n$ ) molecular weights were determined by gel permeation chromatography (GPC). The eluents were monitored with a UV detector (JMST Systems, USA, VUV-24) at 254 nm. Polystyrene was used as the standard. UV-vis absorptions were recorded at 25 °C in the 190-700 nm spectral regions with a Perkin-Elmer Lambda 15 spectrophotometer on DMF solution by using cell lengths of 1 cm. Thermal Gravimetric Analysis (TGA and DTG) data for polymers were taken on a Mettler TA4000 System under N<sub>2</sub> atmosphere at rate of 10 °C/min. Elemental analyses were performed by Vario EL equipment by Arak University.

### Monomer Synthesis.

***N,N'*-(Pyromellitoyl)bis-L-histidine:** 2.18 g, 10.00 mmol of pyromellitic dianhydride (1,2,4,5-benzenetetracarboxylic acid 1,2,4,5-dianhydride) **1**, 3.10 g (20.00 mmol) of L-histidine, 80 mL of acetic acid and a stirring bar were placed into a 250 mL round-bottomed flask. The mixture was stirred at room temperature for overnight and refluxed for 5 h. The solvent was removed under reduced pressure, and the residue solution was decanted and 5 mL of concentrated HCl was added. A white precipitate was formed, filtered off, washed thoroughly with acetone, purified by recrystallization from acetone-water (1:1) solution and dried under reduced pressure to give 3.93 g (80%) of compound **4**. Mp: 311-312 °C,  $[\alpha]_D^{25} = +83.4^\circ$  (0.05 g in 10 mL DMF), FTIR (KBr): 3373 (w), 3269 (w), 3171 (w), 2400-3500 (br), 1778 (m), 1722 (s, br), 1620 (m), 1460 (w), 1388 (s), 1213 (m), 1109 (m), 879 (s), 729 (s), 623 (m) cm<sup>-1</sup>. <sup>1</sup>H NMR (300

MHz, DMSO-d<sub>6</sub>, TMS):  $\delta$ ; 14.11-14.33 (s, br, 4H), 8.96 (s, 2H), 8.31 (s, 2H), 7.41 (s, 2H), 5.18-5.23 (q, 2H), 3.32-3.60 (m, 4H) ppm. <sup>13</sup>C NMR (300 MHz, DMSO-d<sub>6</sub>):  $\delta$ ; 169.15, 165.70, 137.04, 134.25, 129.54, 119.04, 117.53, 52.10, 24.53 ppm. Analysis: calculated for C<sub>22</sub>H<sub>16</sub>N<sub>6</sub>O<sub>8</sub>: C, 53.66; H, 3.28; N, 17.07; found: C, 53.43; H, 3.21; N, 17.01.

**Polymer Synthesis.** Poly(amide-imide)s **6a-g** were prepared from the reaction of *N,N'*-(pyromellitoyl)bis-L-histidine **4** with various diamines **5a-g** by two different methods.

**Method A:** Direct Polycondensation in a Medium Consisting of *N*-methyl-2-pyrrolidone (NMP)/Triphenyl Phosphite (TPP)/Calcium Chloride (CaCl<sub>2</sub>)/Pyridine (Py)

As a typical example, PAI **6b** was prepared as follows: into a 50 mL round-bottom flask, diacid **4** (0.16 g, 0.326 mmol), diamine **5b** (0.08 g, 0.326 mmol), 0.1 g of calcium chloride, 1 mL of NMP, 0.8 mL of TPP, 0.2 mL of Py and a stirring bar were placed. The mixture was heated at 60 °C for 1 h, 90 °C for 2 h and at 120 °C for 8 h. At the end of the reaction, for quench growth polymer chain, the polymer solution was slowly trickled into stirred methanol, giving rise to a stringy precipitate which was washed thoroughly with methanol, collectedly filtrated and dried at 80 °C for 12 h under vacuum to leave 0.22 g (93%) of solid polymer **6b**.

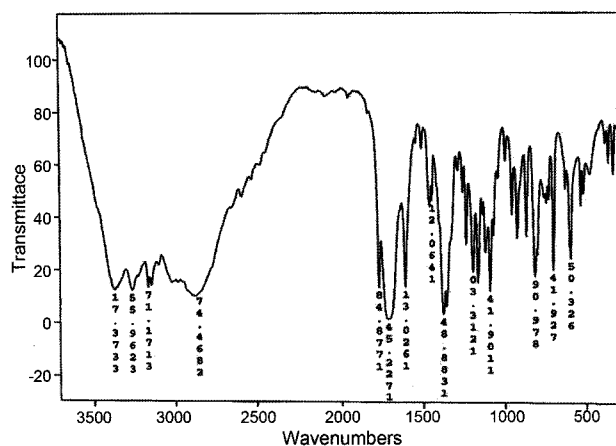
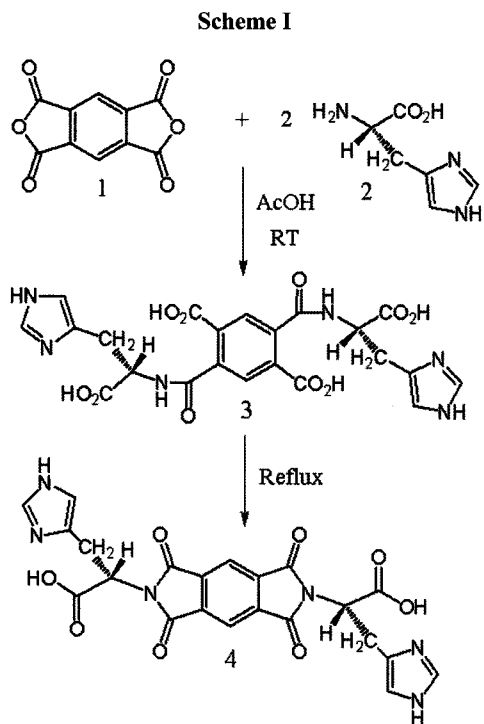
**Method B:** Direct Polycondensation in a Tosyl Chloride (TsCl)/Pyridine (Py)/*N,N*-Dimethylformamide (DMF) System

A Py (0.10 mL) solution of TsCl (0.078 g; 0.411 mmol) after 30 min stirring at room temperature was treated with DMF (0.1 mL; 1.36 mmol) for additional 30 min. The reaction mixture was added dropwise to a solution of diacid **4** (0.067 g; 0.137 mmol) in Py (0.1 mL). The mixture was maintained at room temperature for 20 min, and then to this mixture, a solution of diamine **5b** (0.04 g; 0.137 mmol) in Py (0.4 mL) was added dropwise and the whole solution was stirred at room temperature for 20 min and at 110 °C for 2 h. As the reaction proceeded, the solution became viscous, then was precipitated in 30 mL of methanol and filtered off, dried in vacuum to yield 0.081 g (81%) of the polymer **6b**.<sup>31</sup>

## Results and Discussion

**Monomer Synthesis.** The asymmetric diacid **4** was synthesized by the condensation reaction of one equimolar of dianhydride **1** with two equimolar of L-histidine **2** in an acetic acid solution (Scheme I).

The chemical structure and purity of diacid **4** were proved by using elemental analysis, <sup>1</sup>H NMR, <sup>13</sup>C NMR and FTIR spectroscopy. The measured results in elemental analyses closely corresponded to the calculated ones, demonstrating that the expected compound was obtained. Figure 1 displays FTIR spectrum of diacid **4**. Peaks appearing at 3373 cm<sup>-1</sup> due to the N-H stretching frequency of the free -NH groups, the broad transmission at 3171 cm<sup>-1</sup> due to hydrogen-bonded NH groups, 2400-3500 cm<sup>-1</sup> (acid O-H stretching), 1778 cm<sup>-1</sup> (C=O asymmetric imide stretching), 1722 cm<sup>-1</sup> (C=O acid



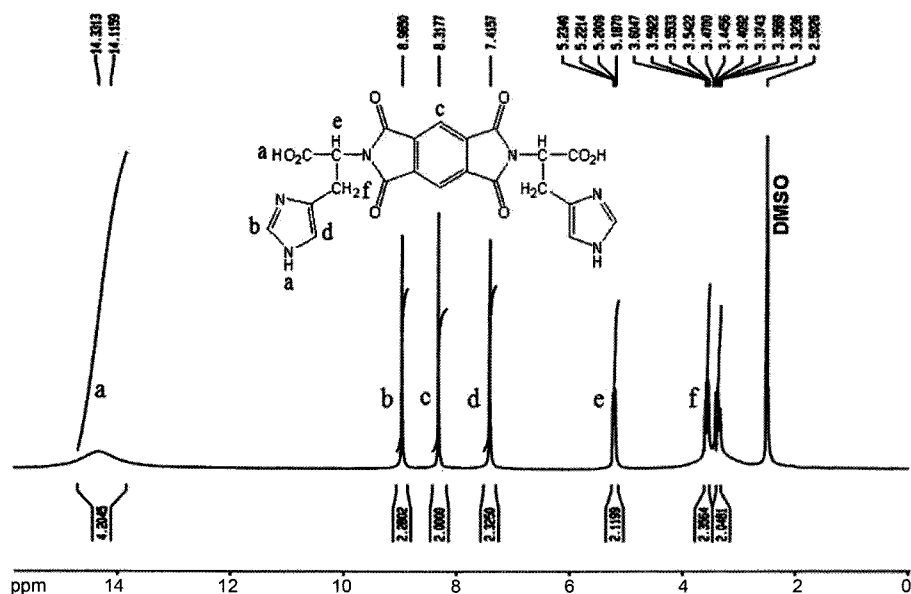
**Figure 1.** FTIR spectrum of diimide-diacid 4.

and symmetric imide stretching), 1388 and 729  $\text{cm}^{-1}$  (imide characteristic ring vibration) confirmed the presence of imide ring and carboxylic groups in this compound.

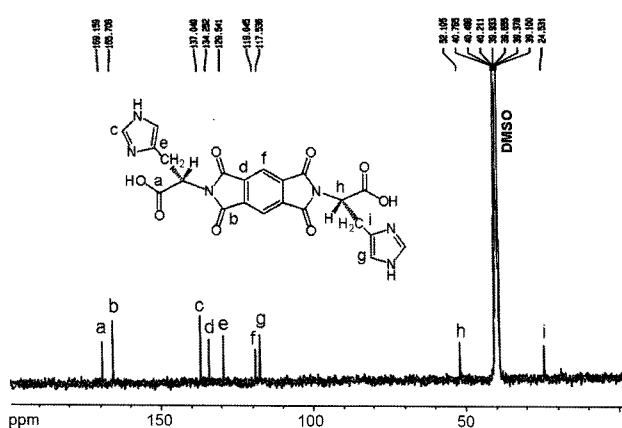
The  $^1\text{H}$  NMR spectrum of diacid 4 is in good accordance with the expected structure. The presence of the O-H carboxylic groups and N-H imidazole ring are characterized by the peak at 14.11–14.33 ppm. The peaks at 5.18–5.23 ppm are assigned to the protons of the chiral center, which appeared as doublet of doublet by the two-diastratopic pro-

tons (Figure 2). The  $^{13}\text{C}$  NMR spectrum of diimide-diacid 4 showed 9 signals, including C(a) and C(b) in carboxylic acid and imide rings, C(h) was relevant to chiral carbon atom that appeared in 52.10 ppm and C(i) related to diastereotopic carbon atom that appeared in 24.53 ppm (Figure 3).

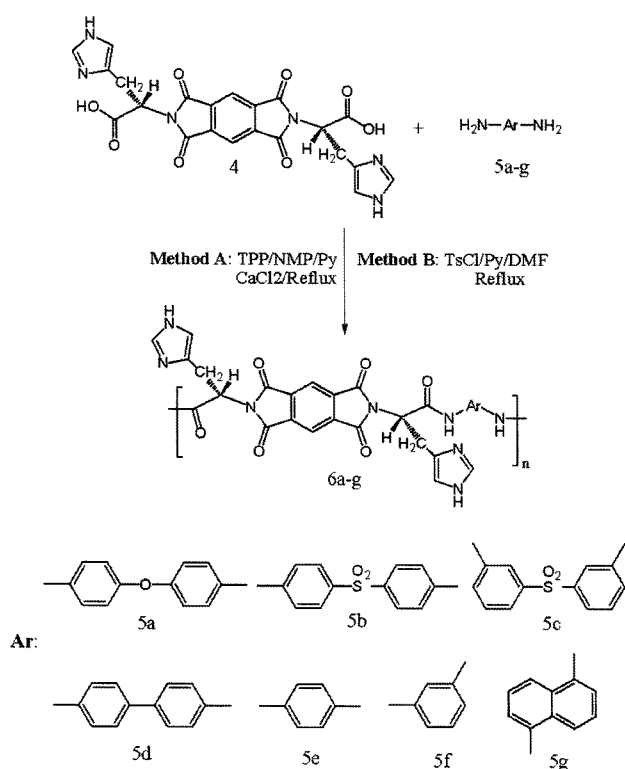
**Polymer Synthesis.** The direct polycondensation of a dicarboxylic acid and diamine is one of the well-known methods for PAI synthesis. In this article, we synthesized PAIs **6a–g** containing imidazole ring in side chain of polymer by the direct polycondensation reactions of chiral diacid 4 with seven various diamines **5a–g** by two different methods such as direct polycondensation in a medium consisting of *N*-methyl-2-pyrrolidone (NMP)/triphenyl phosphite (TPP)/calcium chloride ( $\text{CaCl}_2$ )/pyridine (py) (method A, Scheme II) and direct polycondensation in a tosyl chloride (TsCl)/pyridine (Py)/*N,N*-dimethylformamide (DMF) system (method B, Scheme II).



**Figure 2.**  $^1\text{H}$  NMR spectrum of diimide-diacid 4.


 Figure 3.  $^{13}\text{C}$  NMR spectrum of dimide-diacid **4**.

## Scheme II



In method A for direct polycondensation used TPP/Py/ $\text{CaCl}_2$  as activating agent according to a typical procedure that was shown in Scheme II. The syntheses and some physical properties of these new PAIs **6a-g** are given in Table I. These polymers exhibited number-average molecular weights ( $\bar{M}_n$ ) and weight-average molecular weights ( $\bar{M}_w$ ) in the range of  $1.0\text{--}1.8 \times 10^4$  and  $1.9\text{--}5.4 \times 10^4$ , respectively, as measured by GPC, relative to polystyrene standards. The entire polycondensation reaction readily proceeds in a homogeneous solution, tough and stringy precipitates formed when the viscous PAIs solution was obtained in good yields. The resulting polymers due to presence chiral amino acids in the polymer backbone are optically active and specific rotations measured at a concentration of 0.5 g/dL in DMF at 25 °C.

In method B for the polycondensation of diacid **4** and aromatic diamines **5a-g**, a Vilsmeier adduct was prepared by dissolving TsCl in a mixed solvent of Py and DMF.

The syntheses and some physical properties of these new PAIs **6a-g** are given in Table II. The entire polycondensation reaction readily proceeds in a homogeneous solution, tough and stringy precipitates formed when the viscous PAIs solution was obtained in moderate yields. PAIs **6a-g** obtained in a shorter period by method B, but these polymers obtained with higher inherent viscosities and good yields by method A.

The incorporation of chiral unit in the polymer structure was confirmed by measuring their specific rotations (Tables

 Table II. Synthesis and Some Physical Properties of PAIs **6a-g** by Method B

Diamine	Polymer	Yield (%)	$\eta_{\text{inh}}$ (dL/g) <sup>a</sup>	$[\alpha]_{\text{D}}^{25}$ <sup>a</sup>	Color
<b>5a</b>	<b>6a</b>	78	0.26	+76	Yellow
<b>5b</b>	<b>6b</b>	81	0.32	+77	Yellow
<b>5c</b>	<b>6c</b>	75	0.29	+98	Yellow
<b>5d</b>	<b>6d</b>	81	0.31	+67	beige
<b>5e</b>	<b>6e</b>	65	0.24	+57	Grey
<b>5f</b>	<b>6f</b>	73	0.29	+78	Yellow
<b>5g</b>	<b>6g</b>	69	0.28	+84	Grey

<sup>a</sup>Measured at a concentration of 0.5 g/dL in DMF at 25 °C.

 Table I. Synthesis and Some Physical Properties of PAIs **6a-g** by Method A

Diamine	Polymer	Yield (%)	$\eta_{\text{inh}}$ (dL/g) <sup>a</sup>	$\bar{M}_n$ ( $10^4$ ) <sup>b</sup>	$\bar{M}_w$ ( $10^4$ ) <sup>b</sup>	PDI	$[\alpha]_{\text{D}}^{25}$ <sup>a</sup>	Color
<b>5a</b>	<b>6a</b>	95	0.57	1.0	3.9	4.0	+84	Yellow
<b>5b</b>	<b>6b</b>	93	0.64	2.2	4.8	2.2	+69	Yellow
<b>5c</b>	<b>6c</b>	91	0.55	1.1	1.9	1.7	+87	Yellow
<b>5d</b>	<b>6d</b>	96	0.61	1.4	2.8	2.0	+86	Brown
<b>5e</b>	<b>6e</b>	89	0.35	1.3	3.8	3.0	+67	Brown
<b>5f</b>	<b>6f</b>	93	0.66	1.8	5.4	3.0	+75	Yellow
<b>5g</b>	<b>6g</b>	92	0.46	1.3	4.4	3.4	+69	Grey

<sup>a</sup>Measured at a concentration of 0.5 g/dL in DMF at 25 °C. <sup>b</sup>Measured by GPC in DMF, polystyrene was used as standard.

Table III. Elemental Analysis of PAIs 6a-g

Polymer	Formula		C%	H%	N%
6a	C <sub>34</sub> H <sub>24</sub> N <sub>8</sub> O <sub>7</sub> (656.18) <sub>n</sub>	Calcd	62.19	3.68	17.07
		Found	61.78	3.22	16.87
6b	C <sub>34</sub> H <sub>24</sub> N <sub>8</sub> O <sub>8</sub> S (704.67) <sub>n</sub>	Calcd	57.95	3.43	15.90
		Found	57.02	3.38	15.76
6c	C <sub>34</sub> H <sub>24</sub> N <sub>8</sub> O <sub>8</sub> S (704.67) <sub>n</sub>	Calcd	57.95	3.43	15.90
		Found	56.68	3.41	15.28
6d	C <sub>34</sub> H <sub>24</sub> N <sub>8</sub> O <sub>6</sub> (640.6) <sub>n</sub>	Calcd	63.75	3.78	17.49
		Found	62.76	3.57	17.36
6e	C <sub>28</sub> H <sub>20</sub> N <sub>8</sub> O <sub>6</sub> (564.51) <sub>n</sub>	Calcd	59.57	3.57	19.85
		Found	59.12	3.46	19.81
6f	C <sub>28</sub> H <sub>20</sub> N <sub>8</sub> O <sub>6</sub> (564.51) <sub>n</sub>	Calcd	59.57	3.57	19.85
		Found	58.88	3.51	19.06
6g	C <sub>32</sub> H <sub>22</sub> N <sub>8</sub> O <sub>6</sub> (614.57) <sub>n</sub>	Calcd	62.54	3.61	18.23
		Found	62.14	3.58	18.01

I and II). The quantity and the sign of specific rotation of PAIs are not predictable because optical rotation is highly dependent on the chemical structure of the resulting polymeric materials and any small changes in the structure of polymers has substantial random effect on the optical rotation.

**Polymer Characterization.** The elemental analyses of the resulting PAIs 6a-g were in good agreement with the calculated values for the proposed structure (Table III).

**The Solubility Properties of the Polymers:** The solubility of the polymers 6a-g was tested qualitatively in various solvents. All of the polymers exhibited excellent solubility in aprotic polar solvents such as NMP, DMAc, DMF, DMSO at room temperature, as well as in less polar solvents such as THF, pyridine and *m*-cresol at room temperature or upon heating. The good solubility of these polymers might be due to the presence of the easily soluble groups of imidazole

Table IV. Solubility of PAIs 6a-g

Solvent	6a	6b	6c	6d	6e	6f	6g
H <sub>2</sub> SO <sub>4</sub>	++	++	++	++	++	++	++
DMAc	++	++	++	++	++	++	++
DMSO	++	++	++	++	++	++	++
DMF	++	++	++	++	++	++	++
NMP	++	++	++	++	++	++	++
Pyridine	+	+	+–	+	+	+	+
THF	+–	+–	+–	+–	+–	+–	+–
<i>m</i> -Cresol	+–	+	+	+–	+–	+–	+–
MeOH	–	–	–	–	–	–	–
EtOH	–	–	–	–	–	–	–
CHCl <sub>3</sub>	–	–	–	–	–	–	–
H <sub>2</sub> O	–	–	–	–	–	–	–

Solubility: ++, soluble at room temperature; +, soluble on heating; +–, partially soluble on heating; –, insoluble on heating.

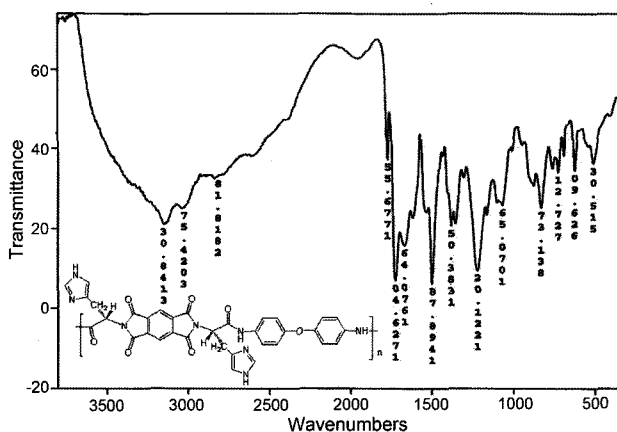


Figure 4. FTIR spectrum of PAI 6a.

groups in the diacid 4. The solubility behavior of the new PAIs was tested in various organic solvent and it also revealed that the new PAIs had much good solubility in many organic solvents. By the introducing of imidazole groups into the polymer backbones solubility of these PAIs was better because imidazole rings in these polymers possesses both proton-donor (-NH-) and proton-acceptor (-N=) hydrogen bonding sites that exhibit specific interactions with polar solvents (Table IV).

The structure of these polymers was confirmed as PAIs by means of FTIR spectroscopy and elemental analyses. The representative FTIR spectrum of PAI 6a shown in Figure 4, FTIR spectra of polymers containing imidazole were widely discussed earlier by several authors.<sup>29,30</sup> The characteristic transmission band around 3367 cm<sup>-1</sup> due to the N-H stretching frequency of the free -NH groups, the broad transmission at 3146 cm<sup>-1</sup> due to hydrogen-bonded NH groups, and a low intense peak at 3014 cm<sup>-1</sup> have been assigned to the stretching frequency of aromatic C-H groups. Broad features appear in the 2500-3500 cm<sup>-1</sup> region indicating that the imidazole N-H proton is hydrogen bonding either to water molecules or to neighboring imines functionalities in a manner typical of imidazoles in the solid state. The polymer showed the C=O asymmetric stretching of imide at 1776 cm<sup>-1</sup>, the C=O symmetric stretching of imide and ester groups at 1726 cm<sup>-1</sup>, bands in the 1620 cm<sup>-1</sup> region characteristic of imidazole, C-N stretching at 1383 cm<sup>-1</sup>, C-O-C stretching at 1070 cm<sup>-1</sup>. All of these PAIs exhibited strong absorption around 1383 and 727 cm<sup>-1</sup>, which shows the presence of the heterocyclic imide groups.

Figure 5 displays <sup>1</sup>H NMR spectrum of PAI 6a. Peak in the region of 10.32 ppm is assigned for N-H amide groups in the polymer backbone, the peak of chiral center appeared in 5.19 ppm and the peak of diastereotopic hydrogens appeared in 3.34-3.57 ppm.

**UV-Vis Absorption Characteristics.** The UV-vis absorption of the new poly(amide-imide)s 6a-g in the DMF solution was studied by a UV spectrophotometer. All polymers

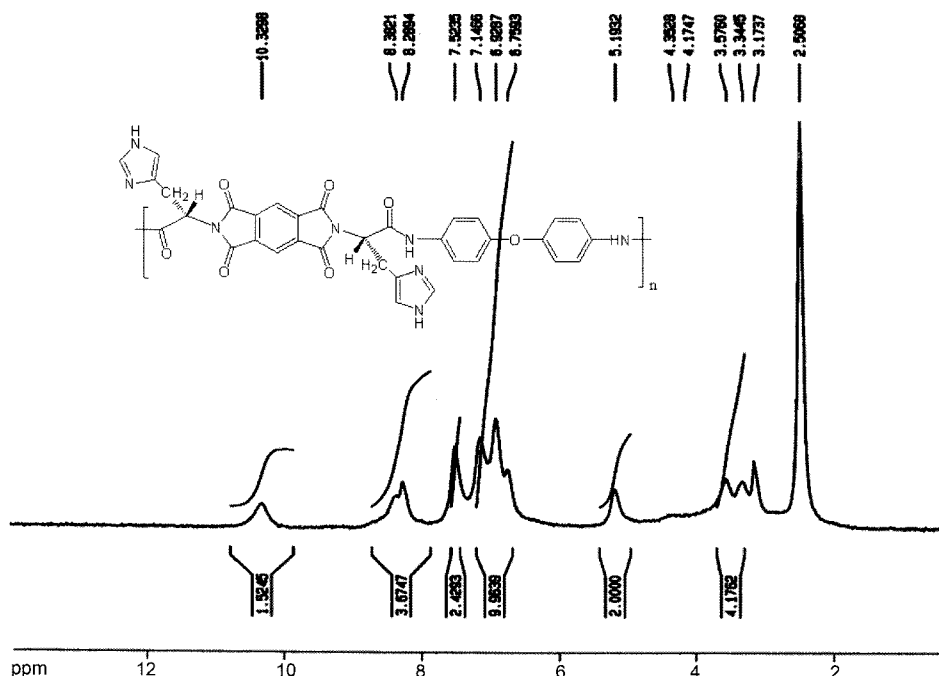


Figure 5.  $^1\text{H}$  NMR spectrum of PAI 6a.

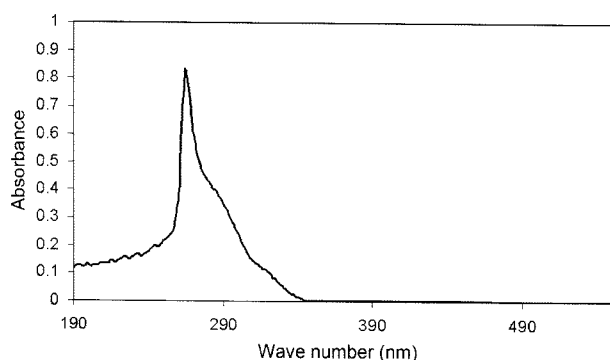


Figure 6. UV-vis spectrum of PAI 6d.

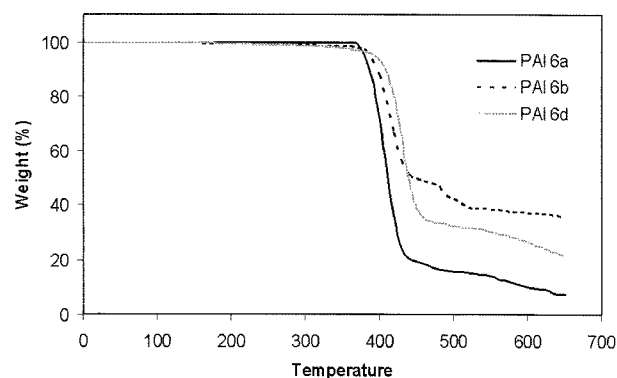


Figure 7. TGA curves of PAIs 6a, 6b and 6d.

solutions exhibit absorption maximum in UV-vis spectra around 265 nm.

The absorption maximum at around 265 nm corresponds to  $\pi \rightarrow \pi^*$  transition of the olefin double bond present in the imidazole moiety and carbon double bonds in aromatic rings in the polymer backbone. The UV-vis absorption spectrum of PAI 6d in DMF is shown in Figure 6. The spectrum of PAI 6d exhibited typical peaks at 264 nm ( $\pi \rightarrow \pi^*$ ).

**Thermal Properties.** The thermal properties of PAIs 6a, 6b and 6d were investigated by TGA in a nitrogen atmosphere at a heating rate of 10 °C/min (Figure 7). All of these polymers showed high decomposition behavior. Initial decomposition temperature, 5 and 10% weight loss temperature ( $T_5$ ,  $T_{10}$ ), and char yields summarized in Table V.

These polymers exhibited good resistance to thermal decomposition up to 380–390 °C in nitrogen. The temperature

Table V. Thermal Behavior of PAIs 6a, 6b and 6d

Polymer	$T_5$ (°C) <sup>a</sup>	$T_{10}$ (°C) <sup>b</sup>	Char Yield (%) <sup>c</sup>
6a	380–385	390–395	10.35
6b	385–390	395–400	37.35
6d	390–395	405–410	26.84

<sup>a,b</sup>Temperature at which 5 or 10% weight loss was recorded TGA at a heating rate of 10 °C/min in  $\text{N}_2$ . <sup>c</sup>Weight percentage of material left after TGA analysis at maximum temperature 600 °C in  $\text{N}_2$ .

of 5% weight loss for all the polymers ranged from 385 to 395 °C and the residual weight at 600 °C ranged from 10.35 to 37.35% in nitrogen. The high  $T_5$  of these PAIs at high temperature region are important. It shows that these polymers have good thermal stability.

## Conclusions

A new series optically active of PAIs **6a-g** containing imidazole ring as a pendent groups were synthesized by direct polycondensation reaction of various aromatic diamines **5a-g** with chiral diacid **4** by two different methods. These polymers showed good thermal stability property and solubility. By introducing pendent units into the chain of polymer backbone, should disturb interchain hydrogen bonding, inherent macromolecular rigidity, and diminish packing efficiency and crystallinity that caused superior solubility. So these polymers are readily soluble in polar amidic solvents rather than another *N,N'*-(pyromellitoyl)bis-L-amino acid.<sup>32-34</sup> Optically active, thermal stability and organosoluble properties can make these polymers attractive for practical applications such as processable high-performance engineering plastics, constructing chiral media for asymmetric synthesis, chiral stationary phases for resolution of racemic mixtures by chromatographic techniques, chiral liquid crystals in ferroelectrics and nonlinear optical devices.<sup>35-37</sup>

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