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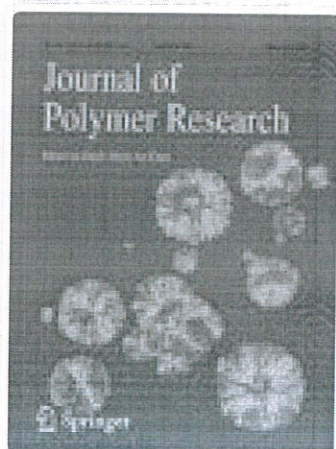


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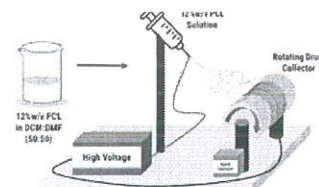
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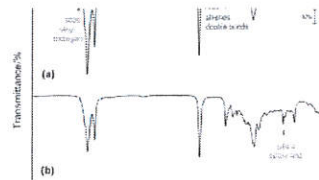
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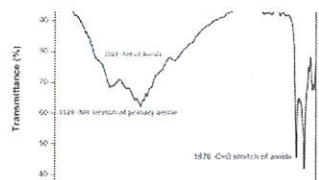
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Synthesis and characterization of aromatic polyamides containing pendant naphthalene-8-oxybenzamide units

Shivaji. D. Ghodke, Aslam B. Tamboli ... Noormahmad N. Maldar

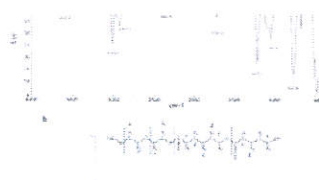
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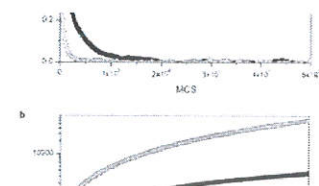
ORIGINAL PAPER | Published: 13 August 2021 | Article: 341



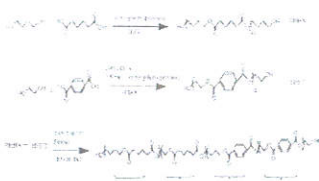
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Effects of introducing Bis(2-hydroxyethyl) terephthalate (BHET) units on crystalline structure, polymorphism and hydrolysis degradation of





Synthesis and characterization of aromatic polyamides containing pendant naphthalene-8-oxybenzamide units

Shivaji. D. Ghodke¹ · Aslam B. Tamboli² · Arati V. Diwate³ · Mahesh B. Gurame⁴ · Vijay P. Ubale⁵ · Makarand D. Joshi⁶ · Noormahmad N. Maldar⁷

Received: 6 June 2021 / Accepted: 11 August 2021
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Abstract

The new aromatic m-catenated diamine, N-(3, 5-diaminophenyl)-4-(naphthalen-8-yloxy)benzamide was synthesized from 1- naphthol and 4- fluoro benzonitrile. A series of novel aromatic polyamides; containing pendant bulky naphthalene-8-oxybenzamide unit; was synthesized from the diamine and several structurally different aromatic diacids such as 4,4'-Oxydibenzoic acid, Naphthalene-2, 6-dicarboxylic acid, 4,4'-Sulfonyldibenzoic acid, Biphenyl-4,4'-dicarboxylic acid, and 4,4'-(perfluoropropane-2, 2-diyl) dibenzoic acid via direct Yamazaki's phosphorylative polycondensation method using triphenyl phosphite (TPP) as a condensing agent in pyridine (Py)/LiCl/1-methyl-2-pyrrolidone (NMP) solvent system. These new kink structured polyamides were characterized by inherent viscosities, solubility in organic solvents, FT-IR, DSC, TGA and XRD techniques. The polyamides were obtained in good yields and had inherent viscosities in range 0.35 and 0.55 dL/g. These polyamides showed good solubility in amide type polar aprotic solvents namely N, N' dimethyl formamide (DMF), 1-methyl-2-pyrrolidone (NMP), N, N' dimethyl acetamide (DMAc), dimethyl sulfoxide (DMSO) and partly soluble in m-cresol, tetrahydrofuran (THF). Polyamides showed glass-transition temperatures in the range 207 °C-245 °C indicating their processability at these temperatures. The 10% weight loss temperatures as determined by the thermogravimetric analysis were more than 413 °C, indicating a good thermal stability. X-ray diffraction patterns of these polyamides indicated the amorphous nature, which is reflected in solubility behavior.

Keywords N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy)benzamide · Pendant naphthalen-8-oxybenzamide unit · Aromatic polyamides · Solubility · Thermal stability

Introduction

Aromatic polyamides are class of high performance materials because of their excellent combination of high thermal properties, good mechanical strength, chemical resistance characteristic, low flammability and dielectrical properties. These properties meet the demands of end-use conditions for technological applications therefore aromatic polyamides have good impact in various fields such as aerospace, military equipment, automotive industry, separation membranes, engineering plastics and electronic instruments [1–5]. However one of the disadvantages of the aromatic polyamides is their low solubility in common organic solvents that restricts their solution processability and limit their many potential applications. Thus there is a strong need to increase their solubility. Aromatic polyamides do not melt or their melt temperatures / glass transition temperatures for amorphous materials are very high to apply conventional

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processing techniques like injection or extrusion. Hence aromatic polyamides those can be processed from solution have received considerable attention and the work has been directed towards the chemical modifications of the backbone to enhance solubility [6, 7]. Investigations revealed that the incorporation of methylene spacers, ether or sulfonyl linkages, non-coplanar moieties and bulky pendant group, in-to the polymer chain were fruitful [8, 9]. The improvements in the solubility of aromatic polyamides is still one of the key points to overcome and efforts have been made to synthesize structurally modified aromatic polyamides having ether linkages in diamines / diacids components which subsequently become part of main polyamide chains [10, 11].

Modification of polymers by incorporation of bulky pendant groups or moieties is more versatile. In particular, introduction of bulky pendant groups has been performed to promote chain separation, increase amorphous character and produce a higher free-volume. Consequently this improved solubility and processability of aromatic polymers while maintaining their outstanding properties [12]. Some bulky pendant groups such as tert-butyl, phenyl or trifluoromethyl were preferred because they promoted chain separation. Aromatic polyamides containing phthalonitrile or other similar pendant groups [13] exhibited good solubility in common organic solvents because these modifications increased the inter-chain distance and decreased the packing efficiency; altered crystallinity in a way to promote the solubility and processability without sacrificing thermal and mechanical properties to any great extent [14–18].

Studies on the aromatic polyamides derived from 4, 4-(1,4-naphthylenedioxy) dibenzoic acid [19] and 4, 4-(2,6-naphthylenedioxy)- dibenzoic acid [20] increased the polyamide solubility without any appreciable loss in their thermal stability [21, 22]. Therefore it was thought that incorporation of naphthaleneoxy, phenoxy and amide group as a side chain or pendant moiety to main polyamide chain would increase the solubility of aromatic polyamides keeping good thermal stability. Further pendant bulky units would result in to loose polyamide chains packing making polyamides less crystalline compared to commercial aromatic polyamides namely Kevlar or Nomex and hence enhance the solubility of such aromatic polyamides bearing bulky pendant moieties.

In this work, the design, synthesis and properties of a series of novel polyamides containing a rigid, bulky naphthalene-8-oxybenzamide moiety, as a pendant group are investigated. Similar structures reported in the literature produced polymers with high internal free volume where local cavities were formed due to the inability of such structures to pack efficiently [23]. To the best of our knowledge there are no reports on the synthesis and properties of aromatic polyamides containing naphthalene-8-oxybenzamide as a pendant group. Thus here we report the design, synthesis,

characterization and properties of a series of novel aromatic polyamides by reacting a new kink structured aromatic diamine, N-(3, 5-diaminophenyl)-4-(naphthalen-8-yloxy) benzamide with structurally different aromatic diacids.

Chemical structure of the new aromatic diamine, N-(3, 5-diaminophenyl)-4-(naphthalen-8-yloxy)benzamide was confirmed by spectroscopic techniques namely, FT-IR, ^1H NMR and ^{13}C NMR. The formation of novel aromatic polyamides was confirmed by FT-IR spectroscopy and inherent viscosity. These polyamides were characterized by solubility in organic solvents, DSC, TGA and XRD to investigate effect of pendant naphthalene-8-oxybenzamide moiety on resulting aromatic polyamide properties.

Experimental

Materials

1-naphthol (99%), 4-fluoro benzonitrile (99%), pyridine(99%), triphenyl phosphite (97%), Palladium charcoal(10% Pd on Carbon), Hydrazine Hydrate (99%) (All Alfa-Aesar); anhydrous potassium carbonate (99.99%), 3, 5- dinitroaniline (97%), lithium chloride (99%), N-Methyl-2-Pyrrolidone (99.8%) (All Sigma-Aldrich), were procured and used as received.

Measurements

Synthesized new aromatic diamine, intermediate organic compounds and polyamides were scanned for FT-IR spectra on a Nicolet spectrometer using KBr pellets. ^1H NMR (400 MHz) and ^{13}C NMR (100 MHz) spectra were recorded on a Bruker Advance spectrometer at 25 °C using CDCl_3 and $\text{DMSO}-d_6$ as solvent and tetramethylsilane as reference. Solubility of polyamides was determined by dissolving 5 mg polyamide in 5 mL solvent at room temperature for 24 h. Inherent viscosities of aromatic polyamides were measured with a polyamide concentration of 0.5 g/dL in NMP solvent at 30 °C using an Ubbelohde suspended level viscometer. Differential scanning calorimetry (DSC) was performed on a Mettler Toledo DSC STAR^c instrument at heating rate of 10 °C/min under nitrogen. Thermogravimetric analysis (TGA) was recorded on a Mettler Toledo STAR^c instrument at a heating rate of 10 °C/min under nitrogen. Wide angle X-ray diffraction (WAXD) was recorded with a Rigaku X-ray diffractometer using polyamide powder.

Synthesis of Diamine N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy) benzamide (3)

- a) **Synthesis of 4-(naphthalen-8-yloxy) benzoic acid (1):** Synthesis of 4-(naphthalen-8-yloxy)benzonitrile

was prepared as per reported procedure [23] by using 1-naphthol and 4-fluorobenzonitrile as a starting material in presence of anhydrous potassium carbonate. Product was recrystallized from absolute ethanol to afford pure 4-(naphthalen-8-yloxy)benzonitrile in 91.06% yield. M. P. 146 °C.

A suspension of the intermediate 4-(naphthalen-8-yloxy)benzonitrile (12.74 g, 0.052 mol) was refluxed with KOH (14.5 g, 0.26 mol) in 500 mL distilled water and ethanol (1:1) for 48 h. The resulting solution was filtered hot, cooled and acidified with conc. HCl to pH 2–3. Light brown precipitate was filtered off, washed several times with hot water and dried. The crude mass was recrystallized from absolute ethanol to get 6.82 g. pure product (**1**) in 93.89% yield. M. P. 152 °C. FT-IR (KBr, cm^{-1}): 3034 cm^{-1} (-OH stretch), 1716 cm^{-1} (carbonyl stretch). ^1H NMR (CDCl_3 , ppm): 7.0 ppm (d, 2H), 7.15 ppm (dd, 1H), 7.5 ppm (m, 3H), 7.7 ppm (d, 1H), 7.9 ppm (d, 1H), 8.03 ppm (d, 1H), 8.08 ppm (d, 2H).

b) Synthesis of 4-(naphthalen-8-yloxy)-N-(3,5-dinitrophenyl) benzamide (2): 3,5-dinitroaniline (5 g, 0.027 mol), lithium chloride 3.10 g, pyridine (7.75 mL), NMP (31.03 mL) and triphenyl phosphite, TPP (11.54 g, 10.16 mL) were placed in a round bottom flask fitted with a magnetic stir bar and a reflux condenser. To the clear solution 4-(naphthalen-8-yloxy)benzoic acid (6 g, 0.027 mol) (**1**) was added, and the reaction mixture was slowly heated to 110 °C; held at that temperature for 12 h with stirring under nitrogen flow. Reaction mixture was then allowed to cool to room temperature, and it was poured in to excess water. The precipitate was filtered, washed with sodium bicarbonate solution, then with hot water and dried. It was recrystallized from absolute alcohol to give 10.5 g. desired dinitro-amide compound (**2**) in 90.67% yield. M. P. 280 °C.

c) Synthesis of N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy) benzamide (3): In a 250 mL three neck round bottom flask equipped with a magnetic stirrer and a reflux condenser 4-(naphthalen-8-yloxy)-N-(3,5-dinitrophenyl) benzamide (**2**) (4.29 g, 0.01 mol), 10% Pd/C (0.29 g) and 110 mL ethanol were heated to reflux and hydrazine monohydrate 99% (20 mL) was added slowly through dropping funnel over a period of 1 h. After additional 12 h of refluxing, the resultant clear, dark solution was filtered while hot to remove catalyst (Pd/C) and the filtrate was subjected to distillation to remove part of solvent. The concentrated solution was poured in to 300 mL water with stirring, giving off-white product, which was filtered, washed with water till free from hydrazine hydrate. The mass was recrystallized from aqueous ethanol to produce 3.25 g. pure diamine (**3**) in 90.52% yield.

M. P. 220–222 °C. FT-IR (KBr, cm^{-1}): 3326 cm^{-1} (-NH stretch amino group), 3205 cm^{-1} (-NH stretch amide group), 1670 cm^{-1} (carbonyl stretch). ^1H NMR (DMSO-d_6 , ppm): 4.4 ppm (2H, s), 5.65 ppm (1H, s), 6.3 ppm (2H, s), 6.9 ppm (2H, d), 7.0 ppm (1H, d), 7.4 ppm (3H, m), 7.5 ppm (1H, d), 7.7–7.9 ppm (3H, m), 8.0 ppm (1H, s), 9.5 ppm (1H, s). ^{13}C NMR (DMSO-d_6 , ppm): 96.98, 101.18, 115.52, 116.9, 121.7, 124.7, 126.2, 126.5, 126.7, 127.0, 128.2, 130.1, 130.3, 135.0, 140.4, 149.1, 151.5, 160.6 and 164.7 ppm.

Polymerization

Diamine, N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy) benzamide (**3**) 0.429 g. (1 mmol), biphenyl-4,4'-dicarboxylic acid (1 mmol), 1 mL Triphenyl phosphite, 2 mL NMP and 0.5 mL pyridine containing 8 wt. % anhydrous lithium chloride (LiCl), were placed in a three neck 100 mL R. B. flask and stirred under nitrogen atmosphere. Mixture was heated to 100 °C and stirred at this temperature for 3 h. The resultant viscous solution was poured into the 200 mL methanol. The resulting polyamide precipitate (PA-4) was washed with methanol, hot water, finally with methanol and was dried.

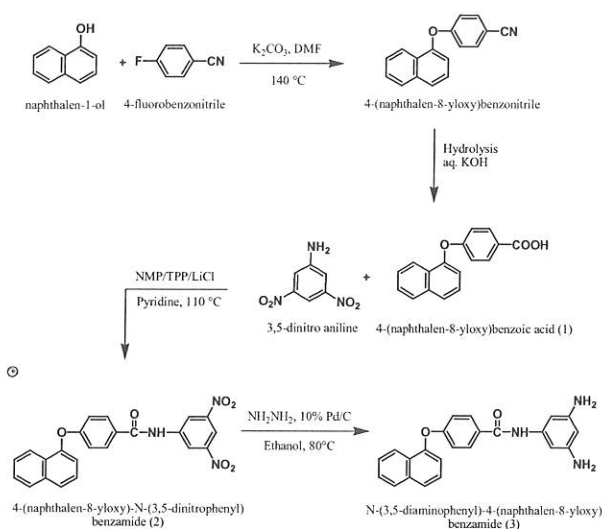
The other polyamides (PA-1 to PA-3, PA-5) were prepared by similar procedure using different diacids. The yields of all polyamides were in range 94–99%.

Results and discussion

The main aim of this investigation was to prepare modified aromatic polyamides with enhanced solubility and processability without much sacrificing their thermal properties.

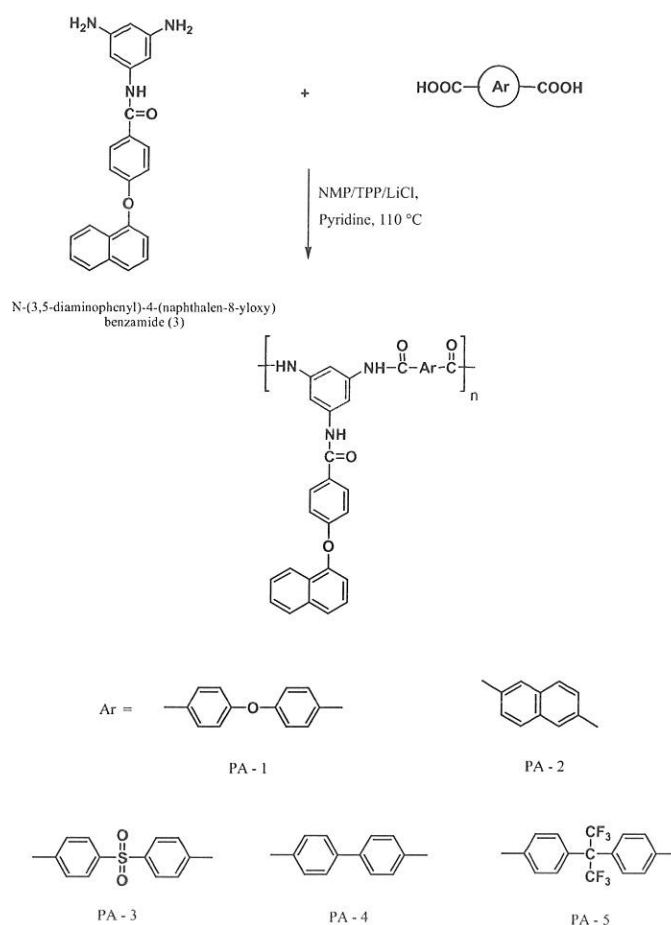
Diamine synthesis and characterization

The new aromatic diamine with 1,3-catenation (kink) and containing naphthyl ether and amide linkages was designed and synthesized in four steps as shown in Scheme 1 and 2. In the step 1- naphthol was reacted with 4-fluorobenzonitrile in presence of anhydrous potassium carbonate to obtain nitrile compound; which was hydrolyzed using potassium hydroxide to get the corresponding carboxylic acid (**1**). In the third step carboxylic acid was condensed with 3,5-dinitroaniline using TPP as condensing agent in pyridine / NMP solvent system to yield dinitro-amide derivative (**2**). This dinitro-amide derivative was then reduced by hydrazine hydrate and Pd/C catalyst in ethanol at reflux temperature to produce desired diamine, N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy) benzamide (**3**) in overall very good (70.17%) yields for four steps performed.



Scheme 1 Synthesis of N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy)benzamide

Scheme 2 Synthesis of polyamides from N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy)benzamide and various aromatic diacid by Yamazaki's phosphorylation method



The chemical structure of the aromatic diamine (**3**) and all the intermediate compounds synthesized were confirmed by TLC, FT-IR, ^1H NMR and ^{13}C NMR spectroscopic techniques. The FT-IR spectrum of, 4-(naphthalen-8-yloxy)benzoic acid (**1**) showed the characteristic absorption bands at around 3034 cm^{-1} (due to $-\text{OH}$ stretch of carboxylic acid) and 1716 cm^{-1} (due to carbonyl stretch of carboxylic acid). The ^1H NMR spectrum of (**1**), showed signals due to the aromatic protons at 7.00 to 8.09 ppm. However the signal corresponding to carboxylic acid proton was not observed; probably due to the fast exchange of carboxylic acid proton with deuterium of the solvent used. The FT-IR spectrum (Fig. 1) of diamine, N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy)benzamide (**3**) showed the characteristic absorption bands of amine groups at around 3326 cm^{-1} (due to $-\text{NH}$ stretch) and 1670 cm^{-1} is (due to carbonyl stretch of amide group). The ^1H NMR spectrum of diamine (Fig. 2) showed signals at 9.52 ppm ($-\text{NH}$ proton of amide) and at 4.45 ppm ($-\text{NH}_2$ group protons). The signals in the range 5.64 ppm to 8.07 ppm were assigned to aromatic protons. The ^{13}C NMR spectrum (Fig. 3) of diamine, N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy)benzamide showed 19 different peaks

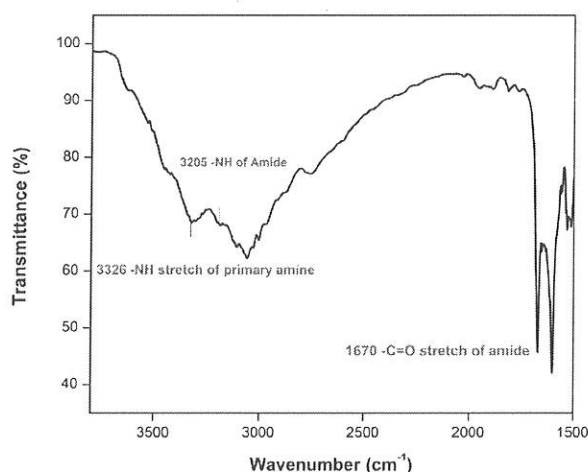


Fig. 1 FT-IR Spectrum of N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy)benzamide

corresponding to 19 different nonequivalent carbons present in the structure. The peak due to carbonyl carbon of amide group appeared at 164.76 ppm. Thus spectral data confirmed the structure of the synthesized diamine (3).

Polyamide synthesis

A series of new aromatic polyamides bearing pendant naphthalene-8-oxybenzamide moiety was prepared by Yamazaki's [24] Direct Phosphorylative polycondensation of new diamine, N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy)benzamide (3) with various aromatic dicarboxylic acids in

NMP / pyridine solvent system containing LiCl using triphenyl phosphite (TPP) as condensing agent. The polymerization reaction proceeded homogeneously and afforded a clear, viscous polymer solution. Polyamides were precipitated by pouring the polymer reaction solutions into methanol with stirring. The prepared polyamides had inherent viscosities in the range 0.35 to 0.55 dL/g with yields 94–99% as shown in Table 1.

The polyamides (PA-1 to PA-5) formation was confirmed by FT-IR spectroscopy. In FT-IR spectrum of polyamide (PA-1) (Fig. 4) the characteristic absorption bands of the amide group at 3267 cm^{-1} (due to the -NH stretching) and at around 1672 cm^{-1} (due to the carbonyl stretching of amide) appeared.

Solubility of Polyamides

The solubility of these aromatic polyamides containing pendant naphthalene-8-oxybenzamide moiety was tested qualitatively in various organic solvents and the results are summarized in Table 2. All these polyamides dissolved in common polar aprotic solvents such as, N, N dimethyl formamide (DMF), 1-Methyl-2-Pyrrolidone (NMP), N, N Dimethyl acetamide (DMAc) and Dimethylsulfoxide (DMSO). Most of the polyamides were partially soluble in solvents such as m-cresol, chlorinated hydrocarbons and tetrahydrofuran (THF); however polyamide-4, derived from biphenyl moiety was not soluble in these solvents. The good solubility of these aromatic polyamides may be due to the structural modification i.e. incorporation of pendant bulky (containing naphthyl, phenylene units linked through ether

Fig. 2 ^1H NMR Spectrum of N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy)benzamide

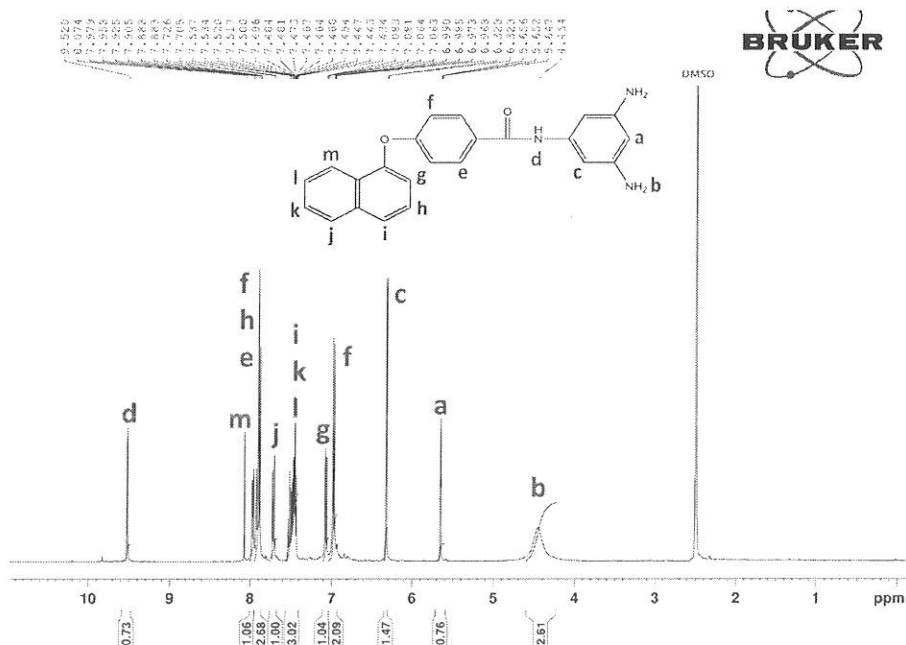
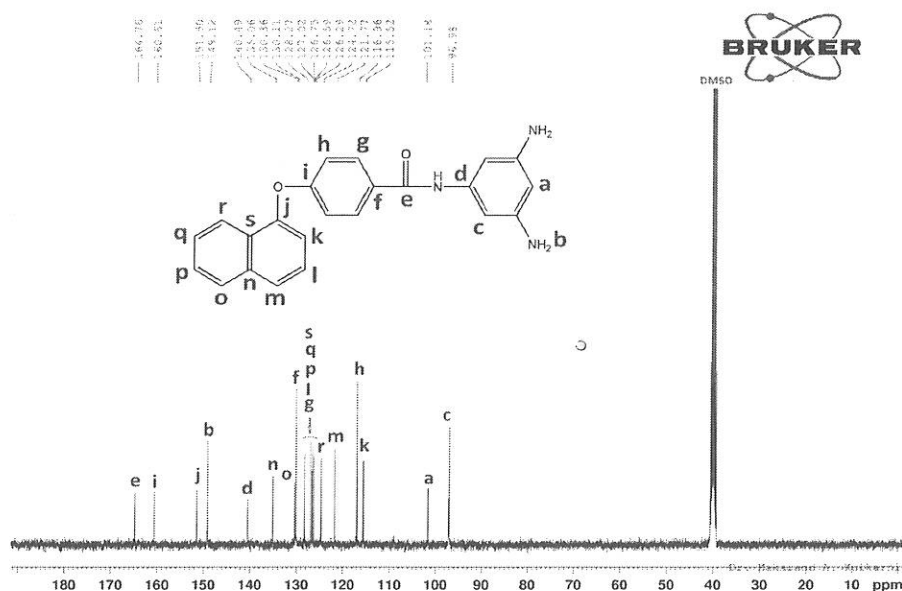


Fig. 3 ^{13}C NMR Spectrum of N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy)benzamide



and amide links) units which decreased intermolecular interactions between polyamide chains, decreased the packing efficiency and thereby decreased crystallinity of polyamides; creating amorphous morphology leading to solubility. Thus pendant groups acted as a spacer and reduced chain-chain interactions. Further m-catenation (1, 3 links) in the aromatic diamine helped for good solubility; as compared to, if it were p-catenated (1,4 link).

Thermal properties

DSC and TGA were used to evaluate thermal properties of these novel aromatic polyamides. Figures 5 and 6 show DSC scans and the thermograms of these aromatic polyamides respectively. The glass transition temperature (T_g); as obtained from the DSC curves, and initial decomposition temperatures (T_i), the temperatures at 10% weight loss

($T_{10\%}$), char yields at 800 °C in nitrogen for (PA-1 to PA-5); as obtained from TGA curves are presented in Table 3. In the DSC analysis no melting peaks were observed, confirming the amorphous nature of these polyamides. The glass transition temperatures of polyamides (PA-1 to PA-5) were in the range 207–245 °C. It was observed that T_g values for PA-1 and PA-3 which contain flexible unit such as ether / sulphone were lower (207 / 215 °C) than the T_g values of the PA-2 or PA-4, (245 / 231 °C) which were derived from rigid naphthalene or biphenyl moiety diacid. Among these polyamides, PA-5 also showed the higher T_g , (228 °C) due to the presence of bulky $-\text{CF}_3$ groups which increased rotational barrier and inhibited local segmental motions making it more rigid.

The initial decomposition temperatures for aromatic polyamides, PA-1 to PA-5 were in the range of 282 to 315 °C. The temperature at which 10% weight loss occurred, for

Table 1 Yield and inherent viscosity of polyamides (PA-1 to PA-5)

Sr. No.	Polyamide code	Diacid	Yield (%)	Inherent Viscosity η_{inh} (dL/g)
1	PA-1	4,4'-Oxydibenzoic acid	99	0.55
2	PA-2	Naphthalene-2, 6-dicarboxylic acid	97	0.41
3	PA-3	4,4'-Sulfonyldibenzoic acid	98	0.35
4	PA-4	Biphenyl-4,4'-dicarboxylic acid	94	0.43
5	PA-5	4,4'-(Perfluoropropane-2, 2-diyl) dibenzoic acid	99	0.45

^aPolymerization was carried out with 1 mmol each of N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy) benzamide and various aromatic diacids

^bN-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy) benzamide

^cMeasured with 0.5% (w/v) polymer solution in NMP at 30 ± 0.1 °C

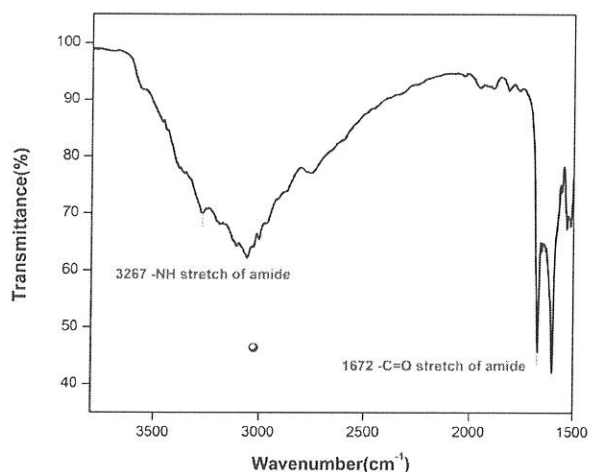


Fig. 4 FT-IR Spectrum of PA-1

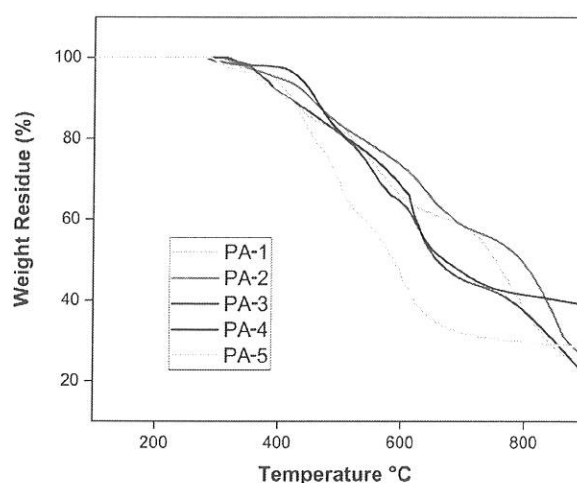


Fig. 6 TGA curves of polyamides, PA-1 to PA-5

Table 2 Solubility of Polyamides (PA-1 to PA-5)

Polyamide → Solvent ↓	PA-1	PA-2	PA-3	PA-4	PA-5
DMF	++	++	++	++	++
DMSO	++	++	++	++	++
NMP	++	++	++	++	++
DMAc	++	++	++	++	++
m-Cresol	+-	+-	+-	--	+-
THF	+-	+-	+-	--	+-
CHCl ₃	+-	--	+-	--	+-
DCM	+-	--	+-	--	--
Conc. H ₂ SO ₄	++	++	++	++	++

++ Soluble, +- Partially soluble, -- Insoluble

Table 3 Thermal properties^a of polyamides (PA-1 to PA-5)

Polyamide Code	^b T _i (°C)	^c T _{10%} (°C)	^d T _g (°C)	Residual wt. (%) at 900 °C
PA-1	295	421	207	22
PA-2	308	451	245	25
PA-3	282	415	215	21
PA-4	315	459	231	38
PA-5	288	413	228	28

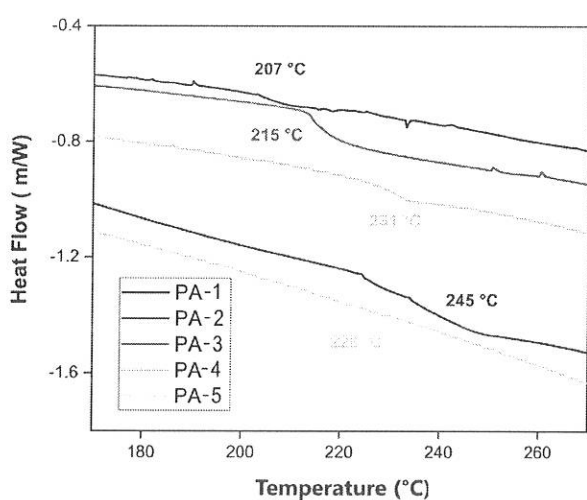
^a Thermogravimetric analysis was conducted at a heating rate of 10 °C / min. under nitrogen atmosphere^b T_i Temp at which weight loss initiated^c T_{10%} Temp at which 10% weight loss was observed^d T_g Determined by DSC measured at a heating rate 20 °C / min. under nitrogen atmosphere

Fig. 5 DSC curves of polyamides, PA-1 to PA-5

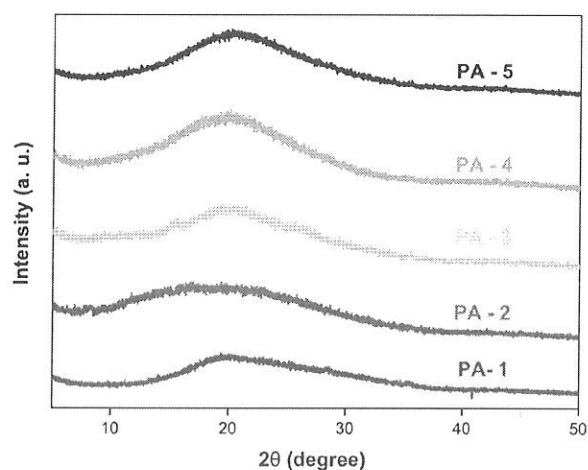


Fig. 7 XRD curves of polyamides, PA-1 to PA-5

these aromatic polyamides, PA-1 to PA-5 were observed in the range 413–459 °C; whereas the residual weights (%) at 900 °C were in range 21–38%. The good thermal stability of these polyamides could be due to increased content of the aromatic structures in main polyamide chain as well in pendant naphthalene-8-oxybenzamide moiety. Further the links such as aryl ether and aryl amide in the pendant naphthalene-8-oxybenzamide moiety were also thermally stable.

Wide angle X-ray Diffraction studies on these aromatic polyamides bearing pendant naphthalene-8-oxybenzamide moiety were conducted in the region of $2\theta = 5\text{--}50^\circ$ at room temperature. Broad hallow peaks were observed in the range of $10\text{--}35^\circ$ and no sharp peaks were seen; indicating amorphous nature (Fig. 7). The amorphous nature of these polyamides may be due to the bulky pendant naphthalene-8-oxybenzamide moiety which did not allow close packing of polyamide chains and reduced considerably the intermolecular force of attraction between them. Thus the amorphous nature could be due to the bulky pendant naphthalene-8-oxybenzamide moiety pendant moiety which significantly increased chain disorder and therefore modified the chain packing. This was reflected in their good solubility of these aromatic polyamides in organic solvents.

Conclusions

Novel aromatic polyamides containing pendant naphthalene-8-oxybenzamide moiety with high thermally stability and with good solubility in organic solvents were successfully synthesized from new diamine, N-(3,5-diaminophenyl)-4-(naphthalen-8-yloxy)benzamide with various aromatic dicarboxylic acids, by Yamazaki's direct phosphorylative polycondensation method. The polyamides had moderate to high molecular weights as indicated by their inherent viscosities, which were in the range 0.35 to 0.55 dL / g. Good solubility character of these aromatic polyamides in organic aprotic polar solvents, may be due to incorporation of bulky pendant naphthalene-8-oxybenzamide units in these aromatic polyamides which avoided close packing of the polyamide chains. All these polyamides bearing pendant naphthalene-8-oxybenzamide moiety had glass transition temperatures in range 207 to 245 °C and showed no weight loss below 282–315 °C. Their 10% weight loss temperatures (T_{10}) were in the range 413 to 459 °C; whereas char yields at 900 °C were in range 21 to 38%; indicating good thermal stability. All these polyamides showed amorphous morphology when studied by WXR and it is reflected in good solubility of these polyamides. These aromatic polyamides having moderate T_g and good solubility in some organic solvents; without any significant loss in thermal stability; could be beneficial towards processability of aromatic polyamides. These modified thermally stable and soluble aromatic


polyamides could be useful as processable high performance polymeric materials.

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