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Synthesis and Characterization of Semifluorinated Aromatic Copoly(ether amide)s

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Two new semifluorinated aromatic copoly(ether amide)s have been synthesized by direct polycondensation reaction of 5-*t*-butyl isophthalic acid (TIPA) with two different aromatic diamines; *bis*-2,2-[4-{2'-trifluoromethyl-4'-(4''-aminophenyl)phenoxy}phenyl]isopropylidene (BTAPPI) and *bis*-9,9-[4-{2'-trifluoromethyl-4'-(4''-aminophenyl)phenoxy}phenyl]fluorenylidene (BTAPPF) and, 4,4'-oxydianiline (ODA) as a comonomer in all cases. These polymers showed very good solubility in organic solvents like DMF, DMAc, NMP and pyridine. The polymers showed very good thermal stabilities, the temperature for 10% wt loss in nitrogen and air were upto 422°C and 412°C, respectively. The copoly(ether amide)s synthesized exhibited glass transition temperature (T_g) 248 (BTAPPI-ODA-TIPA) and 263°C (BTAPPF-ODA-TIPA). DMA analysis showed very good retention of storage modulus of the polymer up to T_g . The copoly(ether amide) films were flexible with tensile strength up to 91 MPa, elongation at break up to 15% and modulus of elasticity up to 1.69 GPa depending on amine used and the exact repeating unit structure. These copoly(ether amide)s were less crystalline in nature in comparison to the homopolyamide synthesized using ODA as diamine but more crystalline than the homopolyamide synthesized using BTAPPI and BTAPPF as diamines. Water absorption study showed hydrophobic nature of the polymers. The copoly(ether amide)s showed non-Newtonian (pseudoplastic) behavior at higher applied shear rate.

Keywords: Semifluorinated copoly(ether amide)s, solubility, mechanical properties, thermal properties

1 Introduction

An increase in the solubility of aromatic polyamides in certain organic solvents would lead to an increase in the range of their practical applications. The aromatic polyamides are commercially important mainly as high-temperature fibers, e.g. Nomex® and Kevlar®. Although these polymers possess many desirable characteristics such as excellent mechanical properties and thermal stability, they are difficult to process because of their limited solubility and high glass transition or melt temperature (1). Therefore, the research has been directed to the synthesis of more tractable high-temperature polymers which are soluble in organic solvents. One approach to increase solubility and lowering glass transition temperature is the incorporation of bulky pendent groups (2–7), or flexible linkages (8–10) into the backbone or introducing molecular asymmetry

(11,12). It has been reported that these modified polymers have good flexibility, processability, and also good solubility in several organic solvents (13). Structural modifications play an important role in the properties of aromatic polyamides. Understanding the structure-property relationship of a polymer requires preparation of different polyamides using different combinations of monomers and comparison of their properties with the corresponding chemical structures. The effect of structural modifications on the final properties of aromatic polyamides would be helpful to tailor the properties for specific industrial applications e.g. filter bags for hot stack gases, insulation materials on electrical motors and separation membranes to purify sea water (14). Researchers have focused on copolycondensation, which leads to an increase in solubility and mechanical properties, accompanied by an apparent decrease in the thermal stability of the polymers (15). In the present investigation, two copoly(ether amide)s have been prepared by the reaction of TIPA with two different fluorinated diamines (BTAPPI and BTAPPF) of fixed mole ratio and using ODA as a comonomer in all cases. The properties of the copolyamides have been compared with the respective homopolyamides reported previously (16).

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Table 1. Molecular weight and inherent viscosity of the polymers

Poly(ether amide)s	Mole ratio (From feed)	Mole ratio of the diamines from $^1\text{H-NMR}$	M_n	PDI	η_{inh} (dL/g) ^c
BTAPPI-TIPA ^a	1.0: 1.0	—	61000	2.49	0.93
BTAPPHI-TIPA ^a	1.0: 1.0	—	60000	2.43	0.80
BTAPPF-TIPA ^a	1.0: 1.0	—	42000	2.71	0.88
ODA-TIPA ^a	1.0: 1.0	—	17000	2.65	0.41
BTAPPI-ODA-TIPA	1.00: 3.54: 4.54	1.0:3.4 (BTAPPI:ODA)	38000	2.76	0.69
BTAPPHI-ODA-TIPA ^b	1.00: 4.00: 5.00	1.0:3.7 (BTAPPHI:ODA)	42000	2.76	0.70
BTAPPF-ODA-TIPA	1.00: 4.00: 5.00	1.0:3.8 (BTAPPF:ODA)	36000	3.17	0.72

^aValues taken from reference (16).

^bValues taken from reference (19).

^cMeasured at a concentration of 0.5 g/dL in DMAc at $32 \pm 0.5^\circ\text{C}$.

2 Experimental

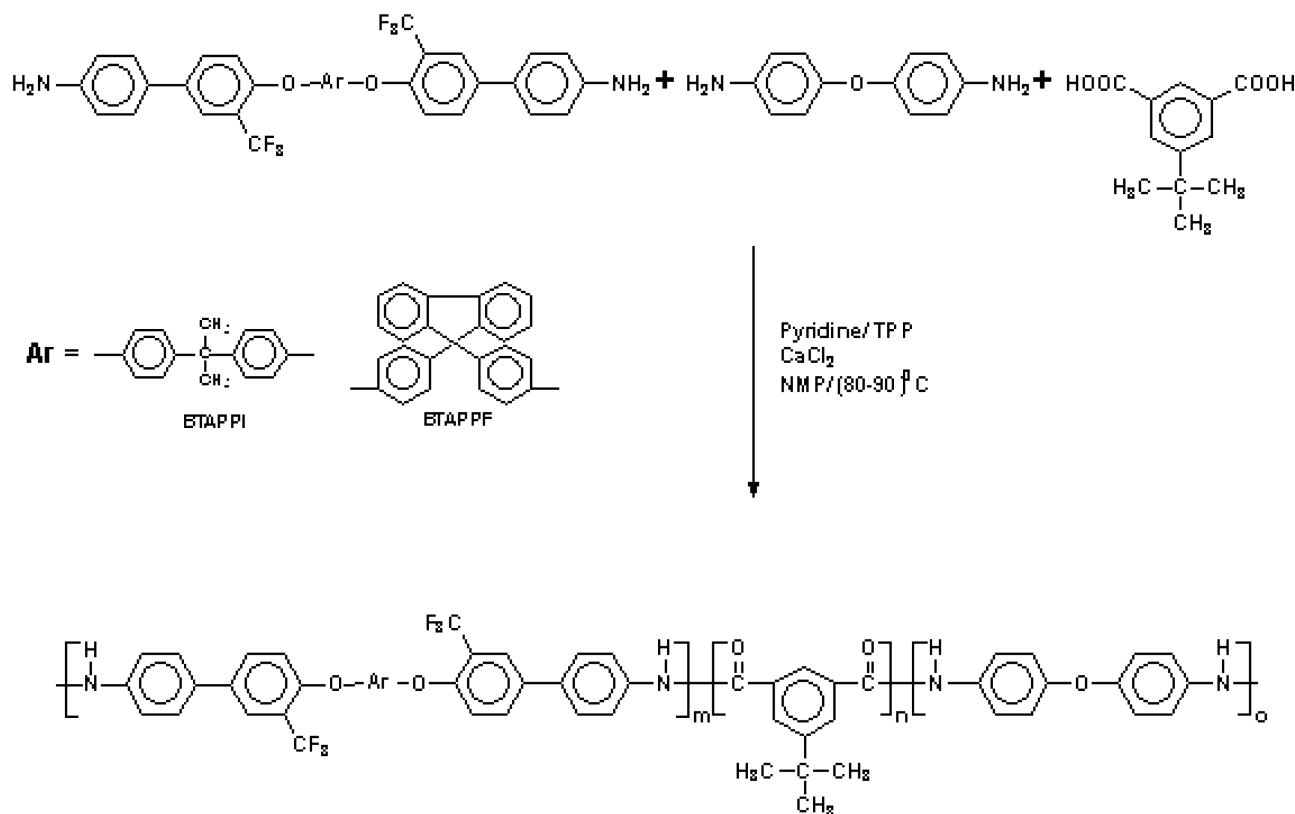
2.1 Materials

All reagents were purchased from Aldrich (USA), and used as received unless otherwise noted. ODA was dried at 80°C prior to use. *N*-methyl-2-pyrrolidone (E. Merck, India) was purified by stirring with NaOH and distilled over P_2O_5 under reduced pressure. Calcium chloride (E. Merck, India) was used after 6 h of drying at 140°C . Pyridine (SD Chemicals, India) was purified by stirring with KOH and distilled under reduced pressure. The diamine monomers used namely; *bis*-2,2-[4-{2'-trifluoromethyl-4'-(4''-aminophenyl)phenoxy}

phenyl] isopropylidene and *bis*-9,9-[4-{2'-trifluoromethyl-4'-(4''-aminophenyl)phenoxy}phenyl]fluorenylidene in this investigation were prepared using the procedure reported in our previous articles (17,18).

2.2 Measurements

$^1\text{H-NMR}$ and $^{13}\text{C-NMR}$ were recorded on a Bruker 300 MHz instrument (Switzerland) using $\text{DMSO-}d_6$ as solvent. FTIR spectroscopy was recorded at room temperature by a FTIR Thermo Nicolet (NEXUS 870) spectrophotometer using KBr pellets and poly(ether amide) samples.



Sch. 1. Reaction scheme of the copoly(ether amide)s

Table 2. Solubility of the copoly(ether amide)s

<i>Poly(ether amide)s</i>	<i>NMP</i>	<i>DMF</i>	<i>DMAc</i>	<i>Pyridine</i>	<i>DMSO</i>	<i>THF</i>	<i>DCM</i>	<i>CHCl₃</i>
BTAPPI-TIPA ^a	++	++	++	++	±	++	±	—
BTAPPHI-TIPA ^a	++	++	++	++	±	++	±	—
BTAPPF-TIPA ^a	++	++	++	++	++	++	±	—
ODA-TIPA ^a	++	++	±	++	++	-	±	—
BTAPPI-ODA-TIPA	++	++	++	++	+	±	±	—
BTAPPHI-ODA-TIPA ^b	++	++	++	++	+	±	±	—
BTAPPF-ODA-TIPA	++	++	++	++	+	±	±	—

^aValues taken from reference (16).

^bValues taken from reference (19).

++, Soluble at room temperature; +, soluble after 24 h; ±, partially Soluble; -, insoluble.

Gel permeation chromatography was performed using an Agilent instrument, Model No. Agilent-1100. DMAc/2% H₂O/(3 g/l) LiCl were used as eluent. The flow rate employed was 0.5 ml/min. Poly(vinylpyridine) was used as a standard and refractive index (RI) detector was used for this purpose. The carbon, hydrogen and nitrogen content of the polymer samples were analyzed by a pyrolysis method using Vario EL (Elementar, Germany). Inherent viscosities of all these polymers were measured at 0.5 g/dL concen-

tration using an Ubbelohde viscometer and DMAc as solvent at 32 ± 0.5°C. Prior to viscosity measurements the polymers were dried in an oven under vacuum at 120°C for 3 h to remove the absorbed solvent and moisture. Differential scanning calorimetry (DSC) analyses were performed on a NETZSCH DSC 200PC differential scanning calorimeter with 10 ± 2 mg samples, at a heating rate of 20°C/min for the determination of the glass transition temperature (T_g). Dynamic Mechanical Analysis (DMA) was

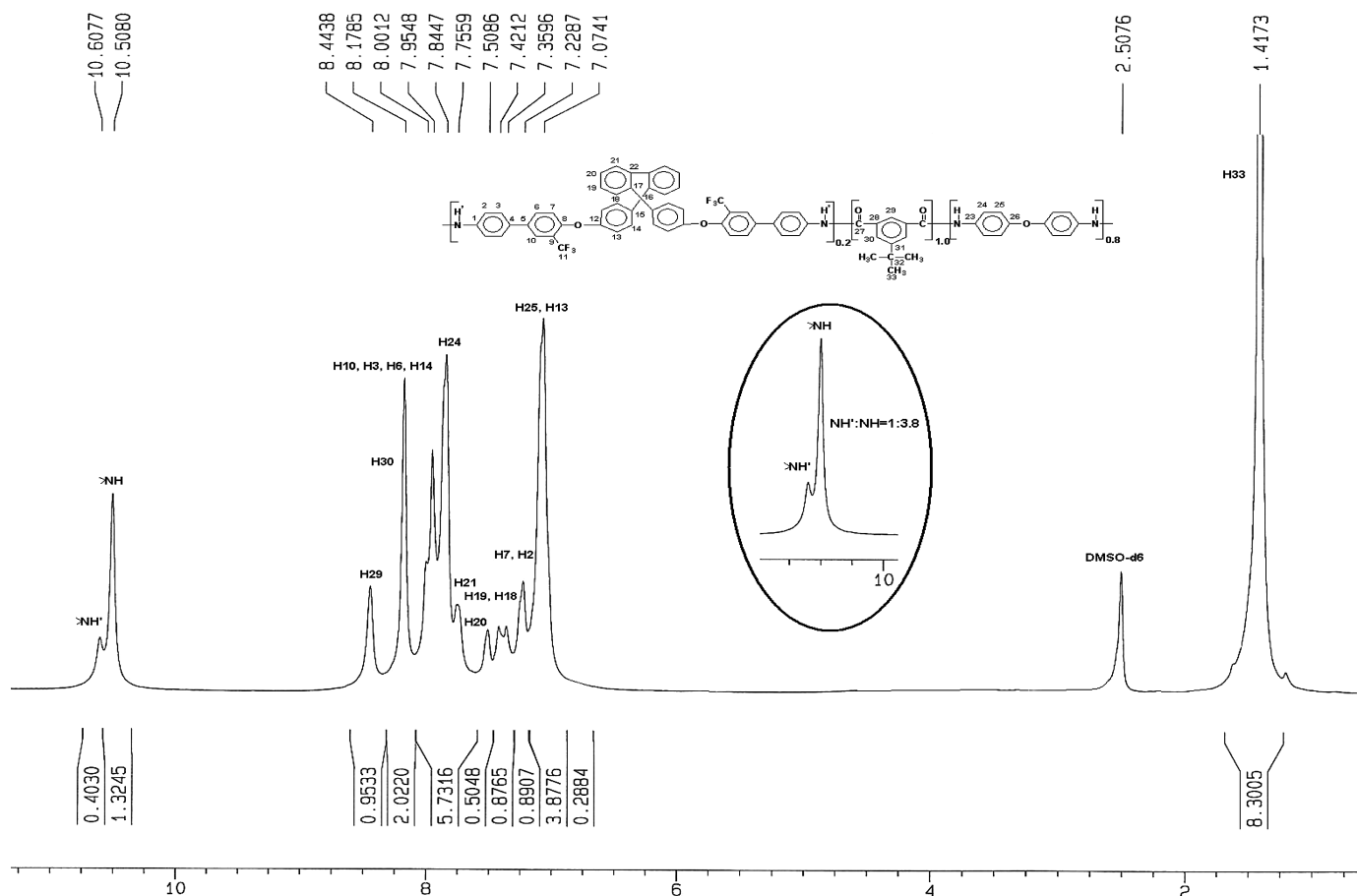


Fig. 1. ¹H-NMR spectrum of the copoly(ether amide) BTAPPF-ODA-TIPA.

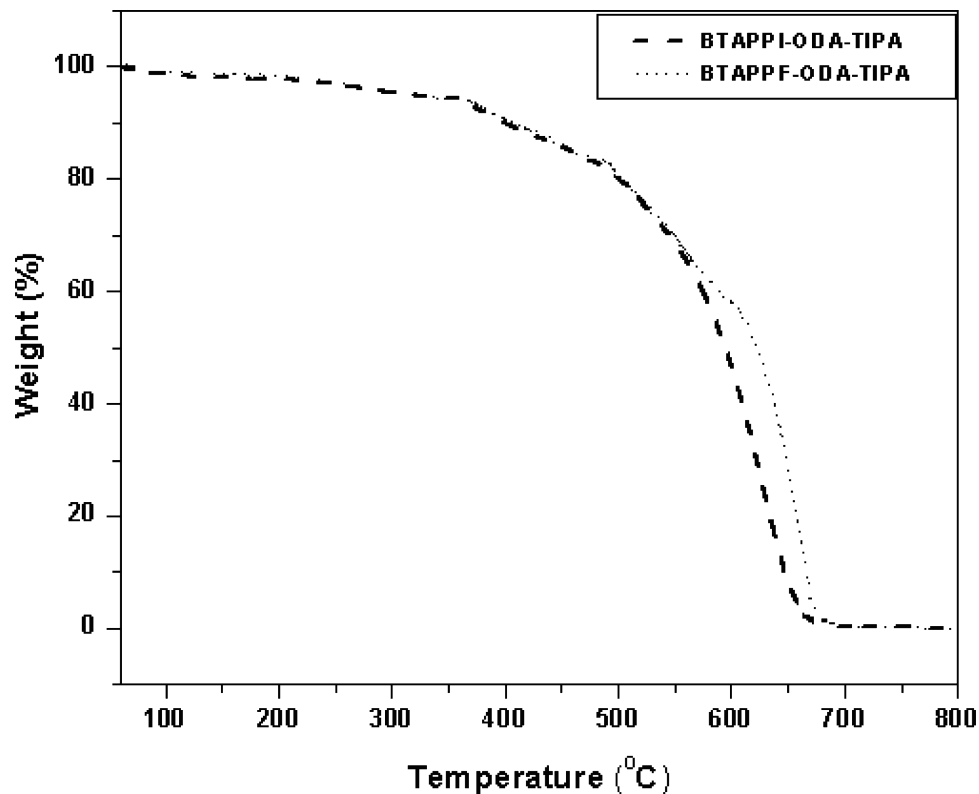


Fig. 2. TGA thermograms of the copoly(ether amide)s in synthetic air.

performed on a TA instrument DMA-2980 (USA) under tension mode on thin film 140–160 μm samples at a heating rate of 10°C/min. and was run at single frequency of 1 Hz in the temperature range 50°C to 300°C. The pyris thermal

analyzer instrument, Al_2O_3 crucible and a flow rate of 100 mL/min of synthetic air/nitrogen (XL grade) was used for thermogravimetric analysis. A 100 Newton load cell and the copoly(ether amide) specimens of the dimension 10 mm \times

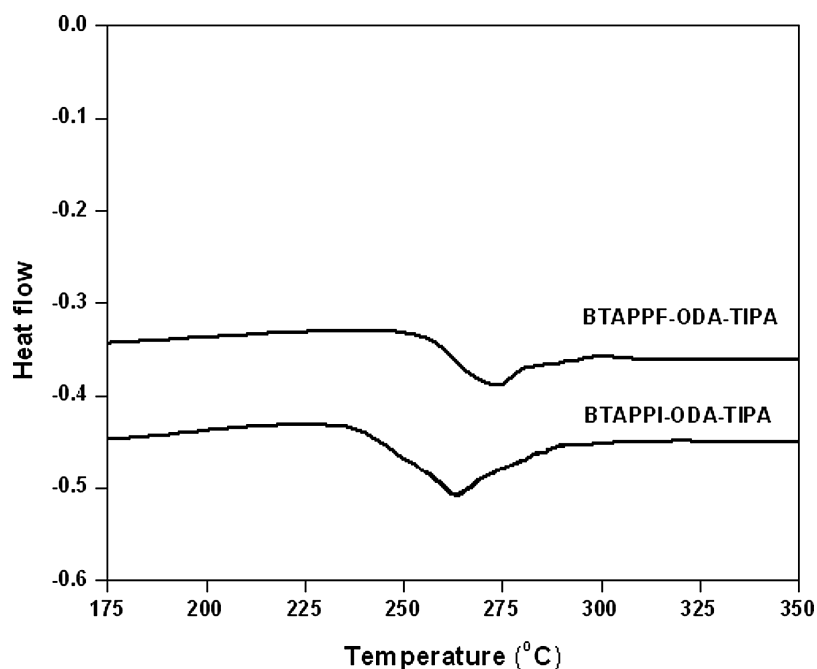


Fig. 3. DSC thermograms of the copoly(ether amide)s.

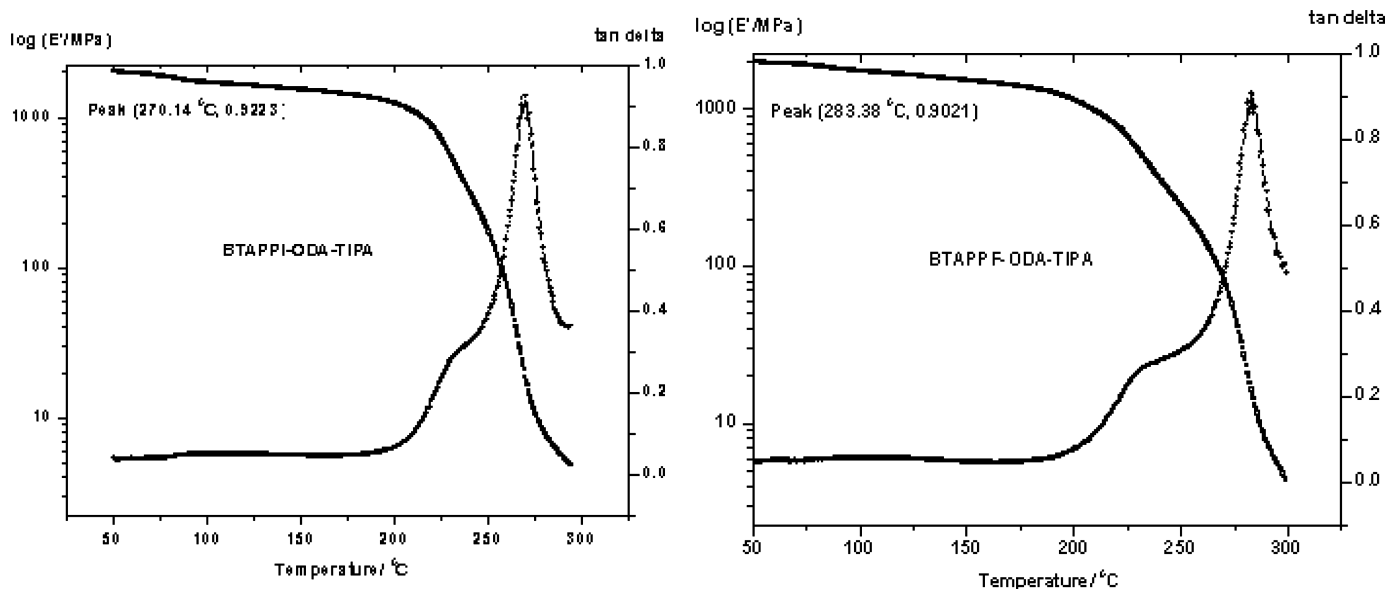


Fig. 4. DMA plots of the copoly(ether amide)s.

25 mm and a thickness around 0.15 mm were used for the measurement of tensile strength and the percentage of elongation at break. All tests were performed under a strain rate of 5%/min of the sample length. Wide angle X-ray diffractograms (WAXD) were recorded by a diffractometer system XPERT-PRO, Goniometer PW3050/60 (Theta/Theta) at 24°C, using CuK α radiation ($\lambda = 1.54 \text{ \AA}$) with continuous scan step time 3 sec and generator settings at 25 mA, 40 kV. Melt viscosity of the synthesized copoly(ether amide)s were done on a TA Instrument Advanced Rheometer AR1000.

2.3 Polymer Synthesis

2.3.1. Copoly(ether amide): BTAPPI-ODA-TIPA

The synthesis of copoly(ether amide) BTAPPI-ODA-TIPA is used as a representative example to illustrate the general synthetic route used to prepare the copoly(ether amide)s. A mixture of 5-*t*-butyl isophthalic acid (TIPA) (0.83 g, 3.751 mmol), 4,4'-diaminodiphenyl ether (ODA) (0.58 g, 2.917 mmol) and *bis*-2,2-[4-{2'-trifluoromethyl-4'-(4''-aminophenyl)phenoxy}phenyl]isopropylidene (BTAPPI) (0.58 g, 0.834 mmol), calcium chloride (0.36 g), NMP (5 mL), pyridine (1.4 mL), and triphenyl phosphite (1.4 mL) were charged into a 100 mL round bottom flask equipped

with a reflux condenser and a nitrogen inlet. The composition of the monomers taken is tabulated in Table 1. The mixture was heated at 95°C with constant stirring for 4 h. As the polycondensation proceeded, gradually the reaction mixture became viscous. After completion of the reaction, the viscous polymer solution was left for cooling. After cooling to room temperature, the viscous polymer was precipitated in a large amount of methanol taken in a beaker with constant stirring. The precipitate was collected by filtration. The fibrous polymer was washed thoroughly with methanol and later with hot water for the complete removal of entrapped CaCl₂ into the polymer. The complete removal of CaCl₂ was checked by AgNO₃ solution. It was dried overnight in an oven at 60°C. The yield was 1.858 g (~97%). The same procedure was adopted for the other polymers. The inherent viscosity of the copoly(ether amide) BTAPPI-ODA-TIPA was 0.69 dL/g as measured at a concentration of 0.5 g/dL in DMAc at 32 ± 0.5°C.

For each polymer, a fixed amount of polymer was dissolved in a DMAc solvent and cast onto a flat petri-dish. It was kept overnight in the vacuum oven at 60°C for the complete removal of entrapped solvent.

Anal. Calcd for (C₇₇H₆₄F₆O₇N₄)_n (1271.387 gmol⁻¹)_n: C, 72.74; H, 5.07; N, 4.40. Found: C, 72.64; H, 4.95; N, 4.38. FTIR (KBr) (cm⁻¹): 3304 (>N-H stretching); 3045 (aromatic C-H stretching); 2963 (aliphatic C-H stretching);

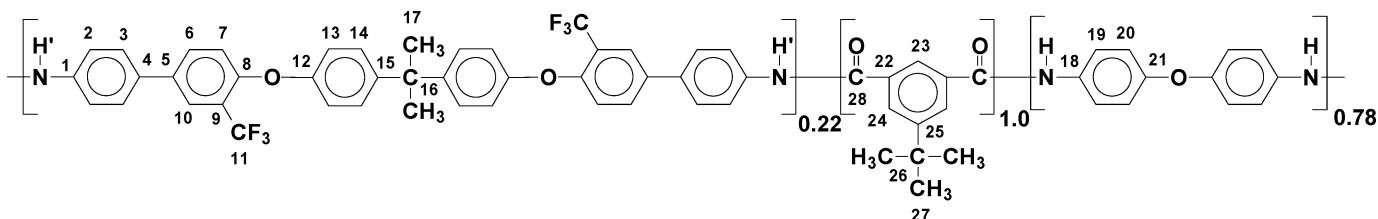


Table 3. Glass transition temperatures and thermal stabilities of the polymers

Poly(ether amide)s	T_g (°C)		T_{dec} (°C)				Char residue ^e
	DSC	DMA	T_{d5}^c	T_{d10}^c	T_{d5}^d	T_{d10}^d	
BTAPPI-TIPA ^a	250	247	—	—	363	475	68.8
BTAPPHI-TIPA ^a	252	251	—	—	421	489	58.8
BTAPPF-TIPA ^a	273	283	—	—	369	481	70.6
ODA-TIPA ^a	268	—	—	—	273	415	63.8
BTAPPI-ODA-TIPA	248	270	337	403	382	419	61.5
BTAPPHI-ODA-TIPA ^b	266	275	397	446	409	476	73.2
BTAPPF-ODA-TIPA	263	283	329	412	357	422	62.6

^aValues taken from reference (16).^bValues taken from reference (19).^c5 and 10% wt loss temperature measured by TGA in synthetic air.^d5 and 10% wt loss temperature measured by TGA in N₂.^eChar residue measured at 700°C in N₂.

1660 (>C=O stretching); 1598 (C=C ring stretching band); 1237 (asymmetric C—O—C stretching); 1134 (C—F stretching); 1050 (symmetric C—O—C stretching).

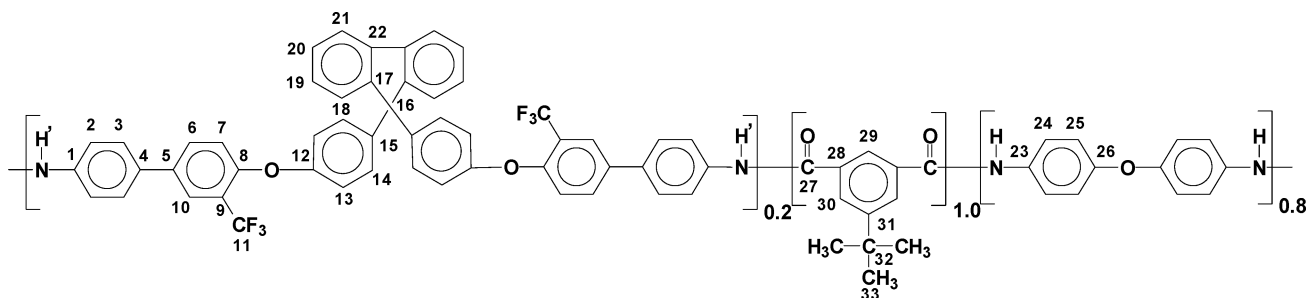
¹H-NMR (DMSO-*d*₆) (300 MHz) δ (ppm): 10.59–10.49 (s, 2H, -NH), (-NH'/-NH = 1/3.4); 8.44 (s, 1H, H²³); 8.17 (s, 2H, H²⁴); 8.00–7.75 (m, 5.76H, H², H¹⁰, H⁶, H³, H¹⁹); 7.30 (s, 2H, H¹⁴, H⁷); 7.07 (s, 4H, H¹³, H²⁰); 1.68 (s, 1.32H, H¹⁷); 1.42 (s, 9H, H²⁷).

¹³C-NMR (DMSO-*d*₆) (75 MHz) δ (ppm): 165.37; 162.31; 153.80; 153.02; 151.39; 146.20; 138.98; 135.03; 134.61; 133.37; 132.02; 128.32; 127.44; 126.92; 125.28; 124.41; 122.37; 121.66; 120.97; 120.37; 119.94; 118.68; 41.84; 34.88; 31.02; 30.65.

2.3.2. Copoly(ether amide): BTAPPF-ODA-TIPA

Anal. Calcd for (C₇₇H₆₄F₆O₇N₄)_n (1271.387 gmol⁻¹)_n: C, 74.98; H, 4.77; N, 4.02. Found: C, 74.82; H, 4.69; N, 4.11. FTIR (KBr) (cm⁻¹): 3303 (>N-H stretching); 3046 (aromatic C—H stretching); 2962 (aliphatic C—H stretching); 1665 (>C=O stretching); 1598 (C=C ring stretching band); 1236 (asymmetric C—O—C stretching); 1134 (C-F stretching); 1050 (symmetric C-O-C stretching).

¹H-NMR (DMSO-*d*₆) (300 MHz) δ (ppm): 10.61 (s, 0.4H, -NH'); 10.51 (s, 1.6H, -NH); (-NH'/-NH = 1/3.8);

**Table 4.** Mechanical properties of the copoly(ether amide)s

Poly(ether amide)s	Tensile strength (MPa)	Elongation at break (%)	Tensile modulus (GPa)	Storage modulus (GPa)
BTAPPI-TIPA ^a	58	10	1.39	1.47
BTAPPHI-TIPA ^a	72	14	1.32	1.85
BTAPPF-TIPA ^a	69	09	1.30	1.54
ODA-TIPA ^a	66	04	1.35	—
BTAPPI-ODA-TIPA	62	11	1.69	2.03
BTAPPHI-ODA-TIPA ^b	81	16	1.35	2.17
BTAPPF-ODA-TIPA	91	15	1.66	2.01

^aValues taken from reference (16).^bValues taken from reference (19).

8.44 (s, 1H, H²⁹); 8.18 (s, 2H, H³⁰); 8.00–7.95 (s, 2.4H, H¹⁰, H³, H⁶, H¹⁴); 7.84 (s, 3.2H, H²⁴); 7.76 (s, 0.4H, H²¹); 7.50 (s, 0.4H, H²⁰); 7.42 (s, 0.4H, H¹⁹); 7.36 (s, 0.4H, H¹⁸); 7.23 (s, 1.2H, H⁷, H²); 7.07 (s, 4H, H²⁵, H¹³); 1.42 (s, 9H, H³³).

¹³C-NMR (DMSO-*d*₆) (75 MHz) δ (ppm): 165.52; 165.26; 162.31; 154.84; 153.53; 153.04; 151.41; 150.47; 141.45; 139.52; 139.03; 135.04; 134.62; 133.33; 132.04; 129.52; 129.35; 127.48; 126.93; 125.95; 125.23; 124.43; 121.62; 120.98; 120.54 (q, $J = 276$ Hz); 120.49; 120.13; 115.27; 63.97; 34.88; 31.02.

3 Results and Discussion

3.1 Polymer Synthesis

The synthesized diamine monomers were copolymerized with ODA and TIPA using NMP as a solvent in the presence of triphenyl phosphite, pyridine and CaCl₂ as the condensing agent. The reaction scheme and the structure of the polymers are shown in Scheme 1. The summary of the polymer synthesis are tabulated in Table 1. These polymers were obtained in quantitative yields with inherent viscosities of 0.69 and 0.72 dL/g, respectively. GPC data show good molecular weight development for these copoly(ether amide)s. The polydispersity index (PDI) values for the synthesized polymers are in the ranges as expected for condensation polymerization techniques.

Table 5. WAXD and water absorption data of the copoly(ether amide)s

<i>Poly(ether amide)s</i>	<i>d</i> -Spacing (Å)	Film quality	Crystallinity (%)	Water absorption ^c (%)
BTAPPI-TIPA ^a	2.10880	Clear, Flexible	5.31	0.27
BTAPPHI-TIPA ^a	2.10958	Clear, Flexible	7.63	0.15
BTAPPF-TIPA ^a	2.10993	Clear, Flexible	9.07	0.60
ODA-TIPA ^a	2.10865	Brittle	10.19	1.47
BTAPPI-ODA-TIPA	2.10877	Clear, Flexible	5.78	0.95
BTAPPHI-ODA-TIPA ^b	2.10948	Clear, Flexible	8.69	0.94
BTAPPF-ODA-TIPA	2.10975	Clear, Flexible	9.75	1.11

^aValues taken from reference (16).

^bValues taken from reference (19).

^cWater absorption after 72 h at (30 ± 1)°C.

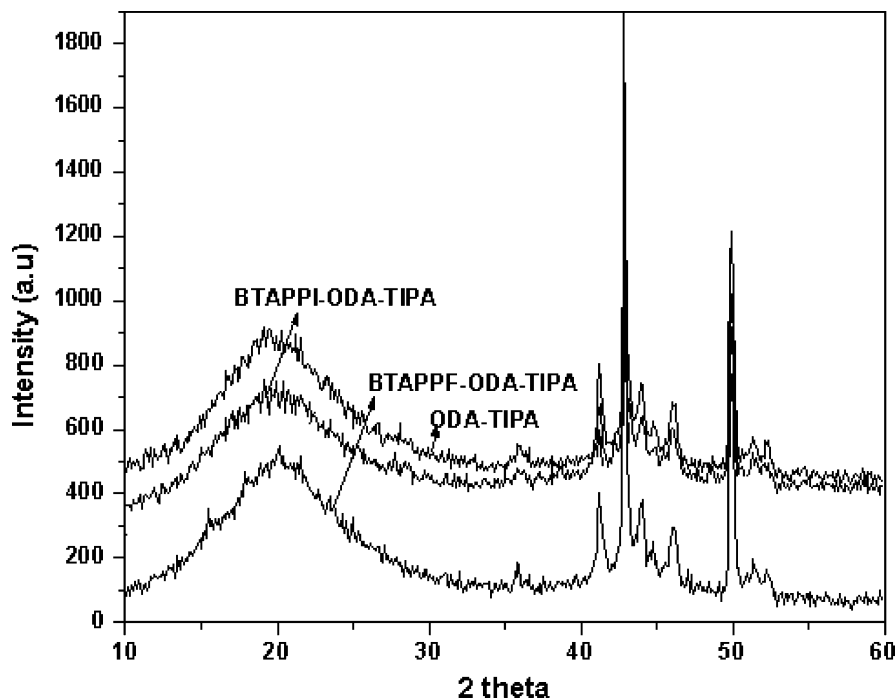
3.2 Solubility

The solubility of the copoly(ether amide)s was tested qualitatively in various solvents and the results are summarized in Table 2. The copoly(ether amide)s exhibited very good solubility in polar aprotic solvents like NMP, DMAc, DMF, and pyridine. It was found that ODA-TIPA is partially soluble in DMAc, but its copolymers show excellent solubility in DMAc. This may be attributed to the incorporation of trifluoromethyl group into the polymer backbone that reduces close packing of the polymer chains and allows the penetration of the solvent molecules easily. These copolymers were insoluble in DMSO though DMSO has similar polarity to the other amide solvents like DMF,

NMP and DMAc. However, this finding is in concurrence with the findings reported earlier in case of semifluorinated poly(arylene ether)s and poly(ether imide)s (17,18).

3.3 Polymer Characterization

The structures of the copoly(ether amide)s were confirmed with ¹H and ¹³C-NMR, FTIR spectroscopy and elemental analyses. One representative ¹H-NMR spectrum for copoly(ether amide) BTAPPF-ODA-TIPA is shown in Figure 1. Figure 1 shows two distinct peaks which correspond to the different amide protons in the copolymer. Amide –NH’ protons originates due to the

**Fig. 5.** WAXD pattern of the copoly(ether amide)s.

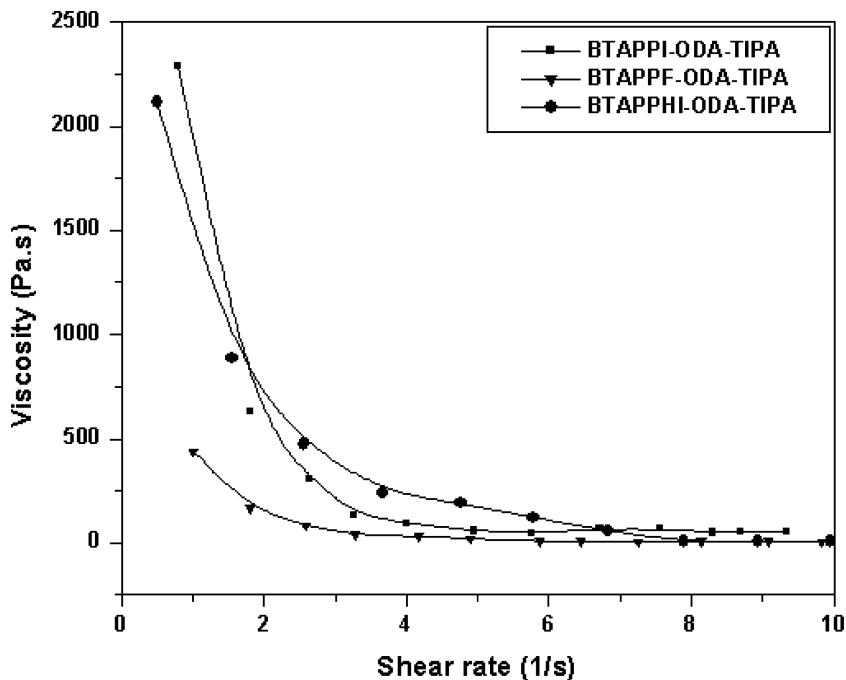


Fig. 6. Rheology study of the copoly(ether amide)s.

reaction of BTAPPF with TIPA showed the peak at 10.61 ppm and the amide -NH protons showed a peak at 10.51 ppm originates due to the reaction of ODA with TIPA. The feed mole ratios of the two diamines used in the synthesis of polymer BTAPPF-ODA-TIPA is BTAPPF:ODA = 1:4. The mole ratios as calculated from the integrated peak area of the amide protons from the Figure 1 was found to be 1:3.8. This variation is within the range of error in the experimental technique. The feed mole ratio of the diamines in the copolymer and the values calculated from proton NMR for other copolyamides are given in Table 1. FTIR spectra supported the formation of copoly(ether amide)s. The stretching bands at 3303–3304 cm^{-1} , 1660–1665 cm^{-1} and 1134 cm^{-1} corresponds to the (>N–H), amide carbonyl (>C=O) and (C–F) groups. The elemental analyses of the resulted polymers were in good agreement with the calculated values which is reported in the experimental section.

The thermal stability and glass transition temperature (T_g) of the polymers were evaluated by thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC), respectively. The thermal analyses data of these polymers are summarized in Table 3. These copoly(ether amide)s exhibited good thermal stability. The 10% wt loss temperatures of the polymers BTAPPI-ODA-TIPA and BTAPPF-ODA-TIPA were found to be 419 and 422°C under nitrogen atmosphere, respectively. The stability of the copolymers is comparable to the respective homopolymers. The polymers showed high char residue (more than 60%) at 700°C under nitrogen. The TGA thermogram

of the copoly(ether amide)s measured in air is shown in Figure 2.

The glass transition temperature of the copoly(ether amide)s was determined by both DSC and DMA. The values obtained from DSC were 248 and 263°C and those from DMA 270 and 283°C for the polymers BTAPPI-ODA-TIPA and BTAPPF-ODA-TIPA, respectively. The DSC thermogram of the copoly(ether amide)s is shown in Figure 3. The T_g values of the copolyamides are comparable to the respective homopolyamides without ODA.

Figure 4 shows the DMA plots of the copoly(ether amide)s. The $\tan\delta$ plot showed a sharp peak with a small hump within 220–250°C. This might be due to different reactivity of the two diamines that may generate blocky structure and as a result the $\tan\delta$ plots showed two T_g s'. The DMA thermograms showed a good retention of storage modulus of the polymers upto the glass transition temperature.

The mechanical properties of the copoly(ether amide)s are tabulated in Table 4. These films (BTAPPI-ODA-TIPA and BTAPPF-ODA-TIPA) showed tensile strength 62 and 91 MPa, elongation at break 11 and 15% and tensile modulus 1.69 and 1.66 GPa, respectively. The tensile strength of the polymer BTAPPF-ODA-TIPA is higher (10 MPa) than the copoly(ether amide) BTAPPHI-ODA-TIPA reported earlier (19). This might be due to the better pi-pi interaction during the film formation of the copolyamides. The storage modulus value of the copoly(ether amide)s (from DMA) were found to be higher (2.03 and 2.01 GPa) than their respective homopolymers (1.47 and 1.54 GPa). This is

possibly due to the use of more rigid ODA as comonomer in the copolyamides. All the copoly(ether amide)s showed an increase in tensile strength and elongation at break with respect to the homopolymers.

The wide angle XRD data of the copoly(ether amide)s is given in Table 5. Wide peaks of the curves are characteristic of amorphous nature of the polymer. All the copoly(ether amide)s exhibited mostly amorphous patterns with a very less crystallinity which is shown in Figure 5. Lower crystallinity value of the copoly(ether amide) BTAPPI-ODA-TIPA in comparison to the ODA-TIPA may be due to the incorporation of bulky trifluoromethyl groups [$V_{wC(CF_3)_2} = 88.5$], (16) which is present in the diamine BTAPPI unit. The amorphous nature of the copoly(ether amide)s imparts to their excellent solubility behavior. This could be attributed to their asymmetric structural units (higher Van der Waals volume) and aryl ether linkages, which decrease the intra- and inter-polymer chain interaction. This was in agreement with the general rule that the solubility increases with decreasing crystallinity. Very little enhancement of the crystallinity was found to be due to copolymerization. This is perhaps due to the higher mole percent of ODA in the copoly(ether amide)s.

The rheology of the synthesized copoly(ether amide)s were measured at around 100°C above the glass transition temperatures of the respective copolymers. Figure 6 represents melt flow behavior of the copoly(ether amide)s. At a higher applied shear rate, the copoly(ether amide)s showed non-Newtonian (pseudoplastic) behavior. Due to the copolymerization melt flow viscosity of the copoly(ether amide) decreases with respect to the homopolymers.

Water absorption of the polymers is an important factor when the materials are used for some specific application like pervaporation, insulation etc. The percent water absorption after 72 h of the copoly(ether amide)s were measured at $30 \pm 1^\circ\text{C}$. The water absorption values of the copolymers lies between 0.95 to 1.11%. The water absorption values are summarized in Table 5.

4 Conclusions

Two novel organosoluble semifluorinated copoly(ether amide)s have been prepared by a direct polycondensation

method. These polymers showed moderate to high molecular weight. The solvent cast polymer films were amorphous in nature as evidenced by WAXD. The synthesis of the copoly(ether amide)s showed better mechanical performance and comparable thermal stabilities in comparison to the analogous homopolymers. These copoly(ether amide)s may find application in the pervaporation application.

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