Electronic Supplementary Material (ESI) for Polymer Chemistry.

Reduced coefficient of linear thermal expansion of colorless and transparent polyimide by introducing rigid-rod amide unit: synthesis and properties

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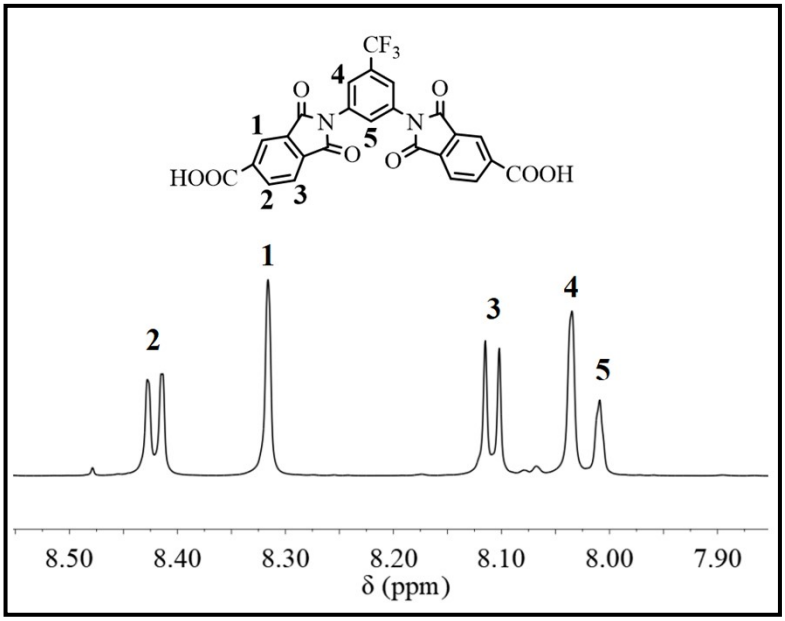

Fig. S1 [1]H-NMR spectra of the 2,2'-(5-(trifluoromethyl)-1,3-phenylene)bis(1,3-dioxoisoindoline-5-carboxylic acid) (DAc-1)

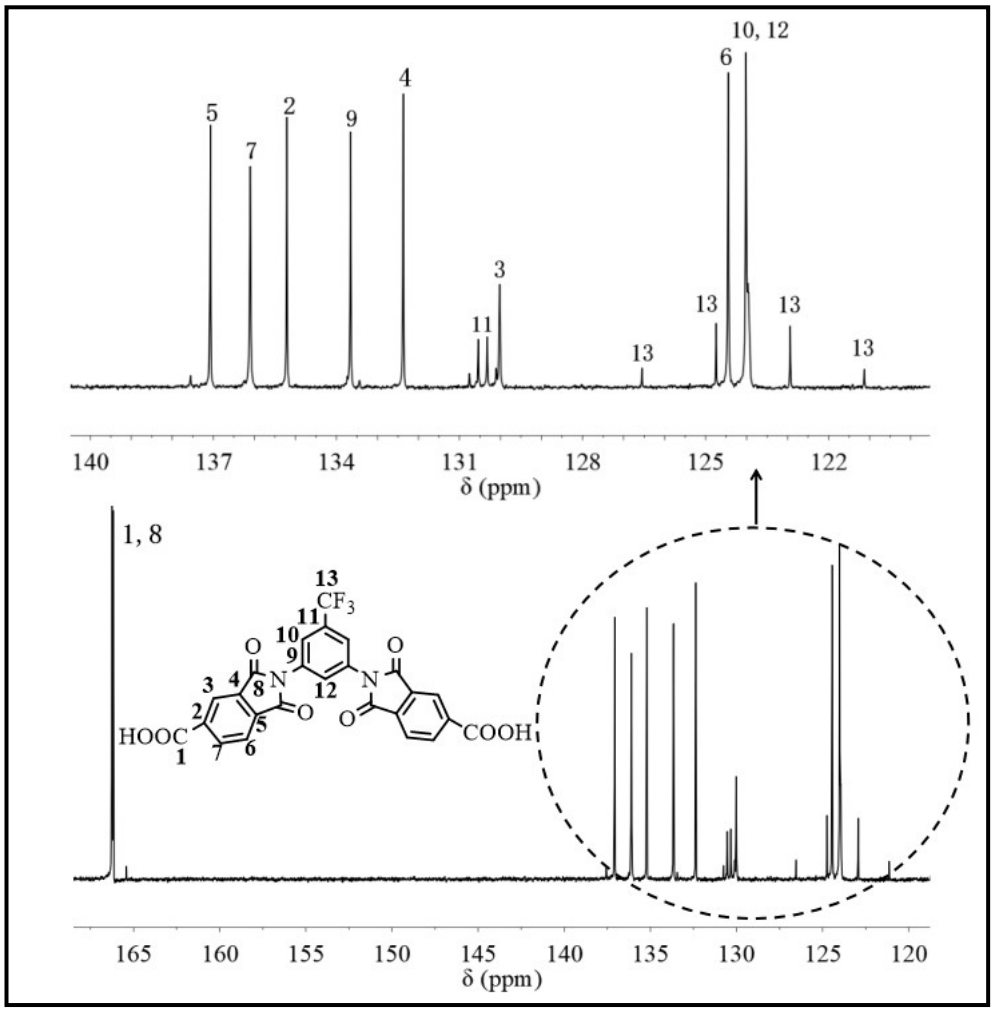

Fig. S2 ^{13}C-NMR spectra of the 2,2'-(5-(trifluoromethyl)-1,3-phenylene)bis(1,3-dioxoisoindoline-5-carboxylic acid) (DAc-1)

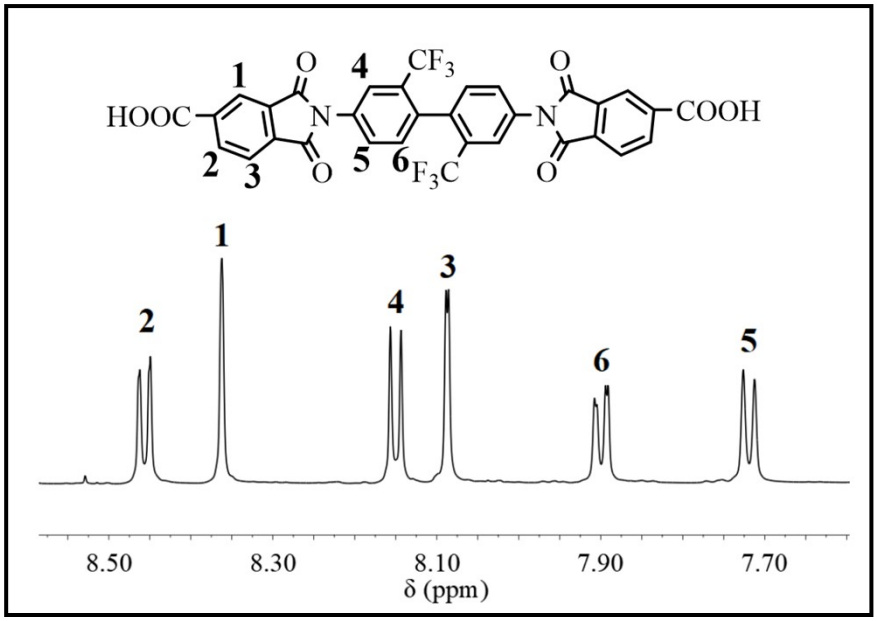

Fig. S3 ^{1}H-NMR spectra of the 2,2'-(2,2'-bis(trifluoromethyl)-[1,1'-biphenyl]-4,4'-diyl)bis(1,3-dioxoisoindoline-5-carboxylic acid) (DAc-2)

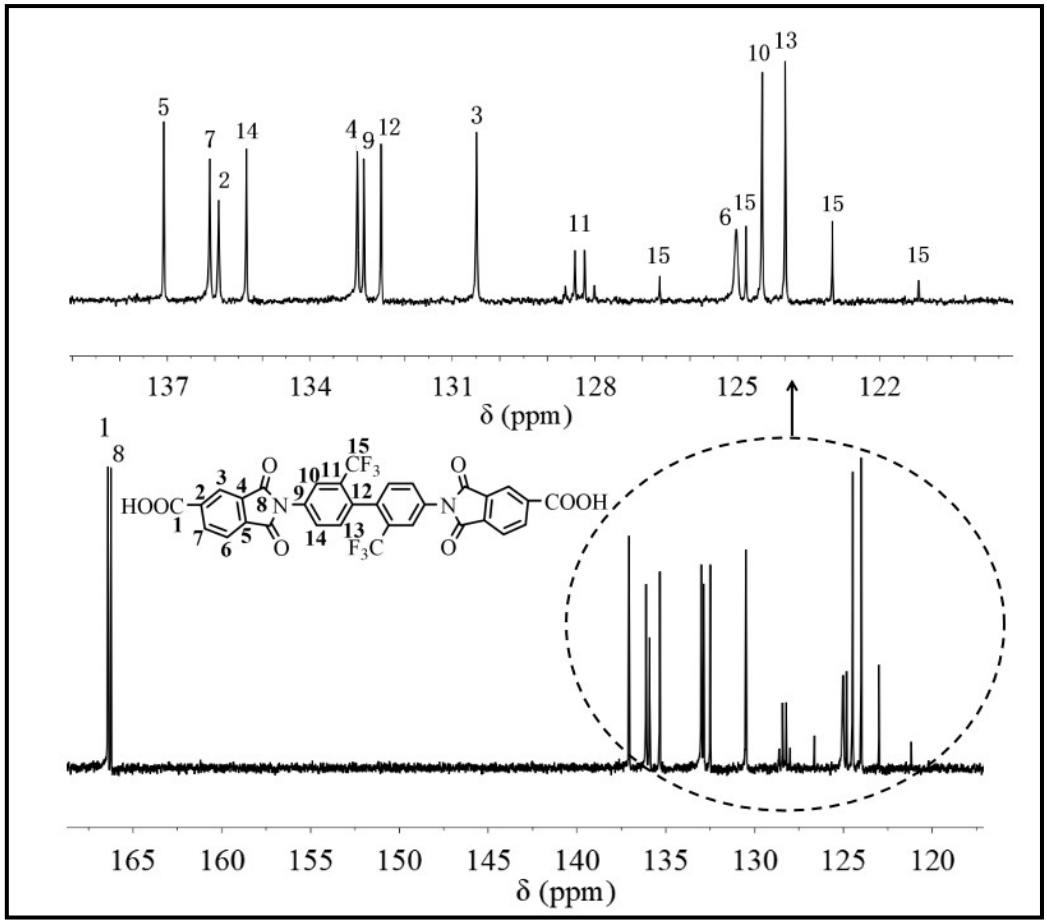

Fig. S4 ^{13}C-NMR spectra of the 2,2'-(2,2'-bis(trifluoromethyl)-[1,1'-biphenyl]-4,4'-diyl)bis(1,3-dioxoisoindoline-5-carboxylic acid) (DAc-2)

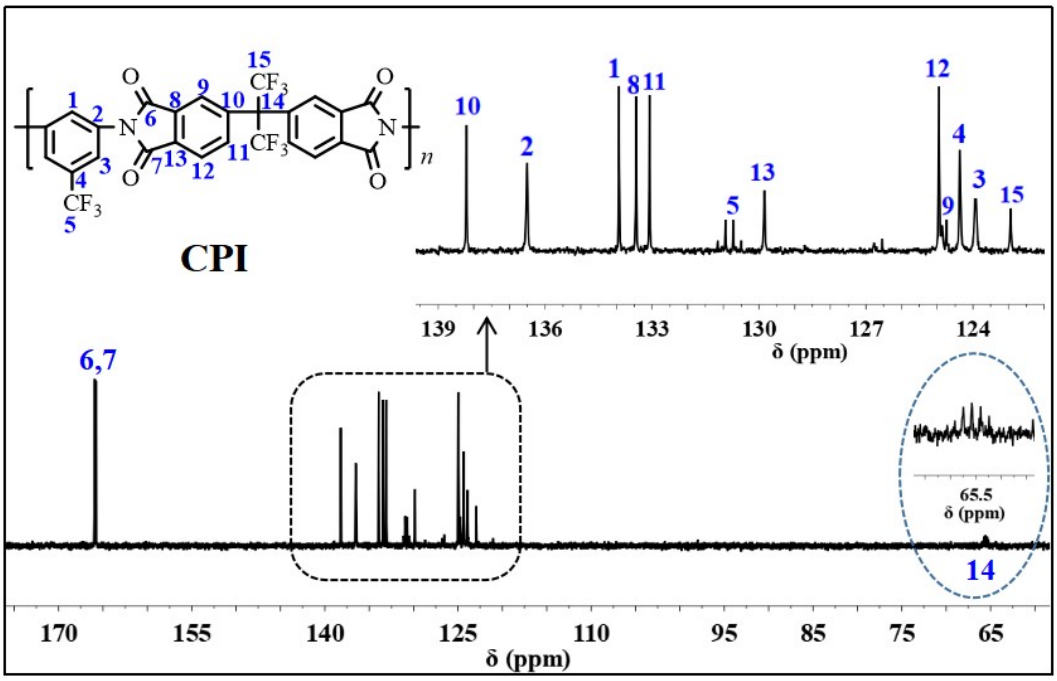

Fig. S5 ^{13}C-NMR spectra of CPI

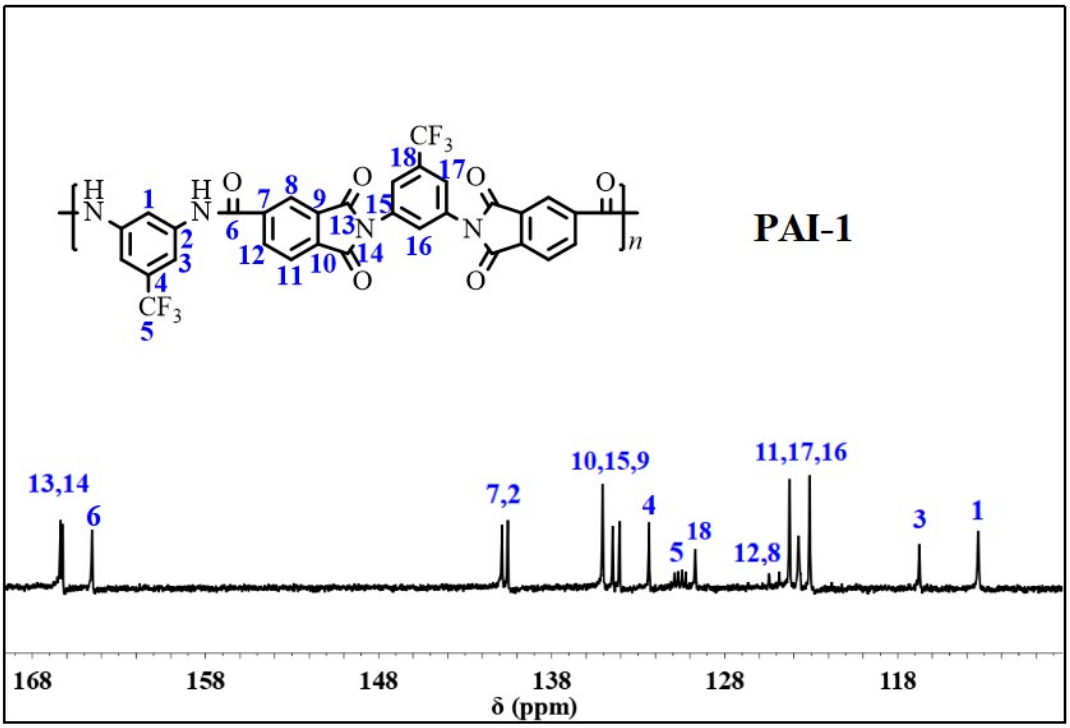

Fig. S6 ^{13}C-NMR spectra of PAI-1

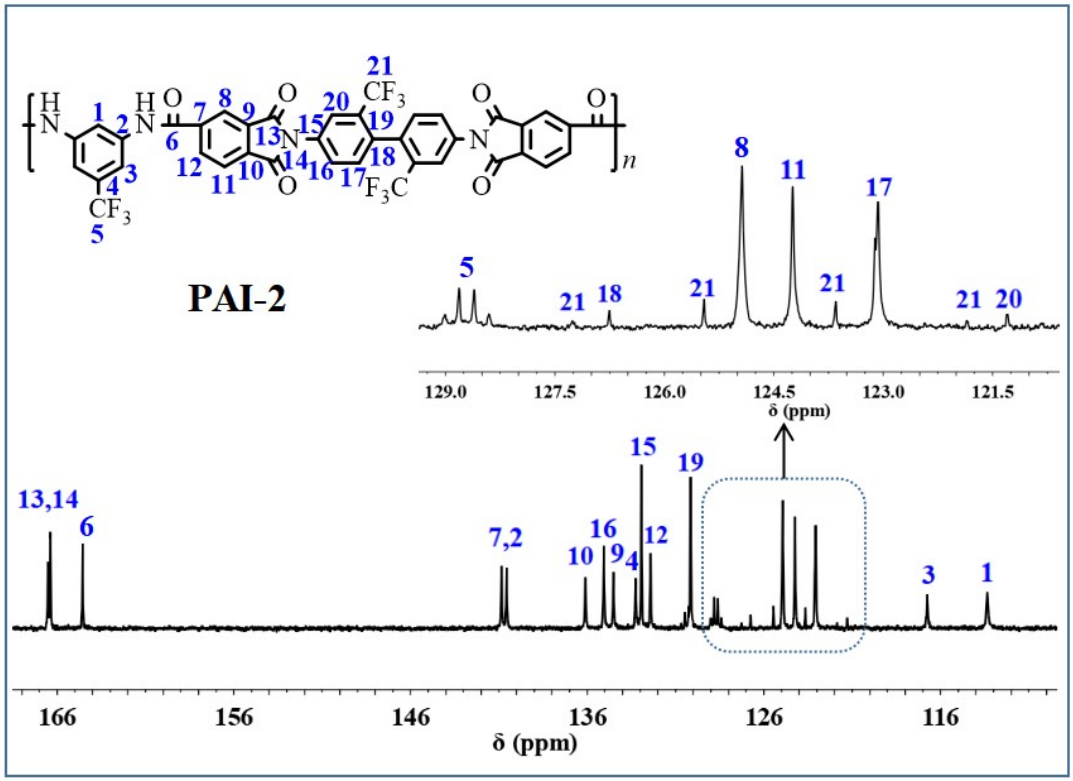

Fig. S7 ^{13}C-NMR spectra of PAI-2

Table S1 Summary of the GIWAXS peak positions

In-plane	Peak position (nm^{-1})	Characteristic distance (Å)	Assignment	Out-of-plane	Peak position (nm^{-1})	Characteristic distance (Å)	Assignment
CPI	6.61	9.50		CPI	6.66	9.43	
	9.00	6.98	ch-pack		9.00	6.98	ch-pack
	12.8	4.93			11.6	5.50	π -π stack
					12.8	4.91	
PAI-1	8.47	7.41	ch-pack	PAI-1	8.49	7.40	ch-pack
	11.1	5.64			11.5	5.48	
	13.9	4.51			12.1	5.19	π -π stack
					14.3	4.38	
PAI-2	8.58	7.32	ch-pack	PAI-2	8.35	7.52	ch-pack
	11.4	5.50			11.5	5.45	
	14.4	4.36			11.8	5.30	π -π stack
					14.3	4.40	

Table S2 Birefringence of CPI and PAIs films

Code	n_{TE}[a]	n_{TM}[b]	n_{AV}[c]	Δn[d]
CPI	1.561	1.555	1.559	0.0060
PAI-1	1.654	1.598	1.635	0.056
PAI-2	1.663	1.564	1.630	0.098

[a]n_{TE}: the in-plane refractive index. [b]n_{TM}: the out-of-plane refractive index. [c]n_{av}: the average refractive index ($n_{av} = (2n_{TE} + n_{TM})/3$). [d]$\Delta n$: birefringence ($n_{TE} - n_{TM}$).

Table S3 The solubility of CPI and PAIs films

Code	Solvent [a]					
	DMAc	DMF	NMP	DMSO	m-Cresol	THF
CPI	++	++	++	+	+	+
PAI-1	++	+	++	+	+	++
PAI-2	++	++	++	++	+	++

[a] Legend: (++) soluble at room temperture, (+) partially soluble at room temperture, soluble on heating 80 ^{o}C. The solubility was determined using 10 mg film in 1 ml of solvent.