Supporting Information

Synthesis of novel Co(II) complexed bipyrimidine polyimide and preparation of thin film composite membranes

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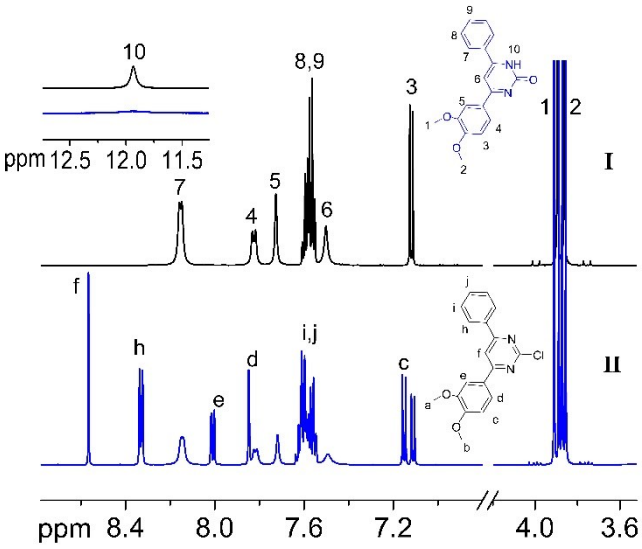

Fig. S1 ^{1}H NMR spectra of compound I and compound VI.

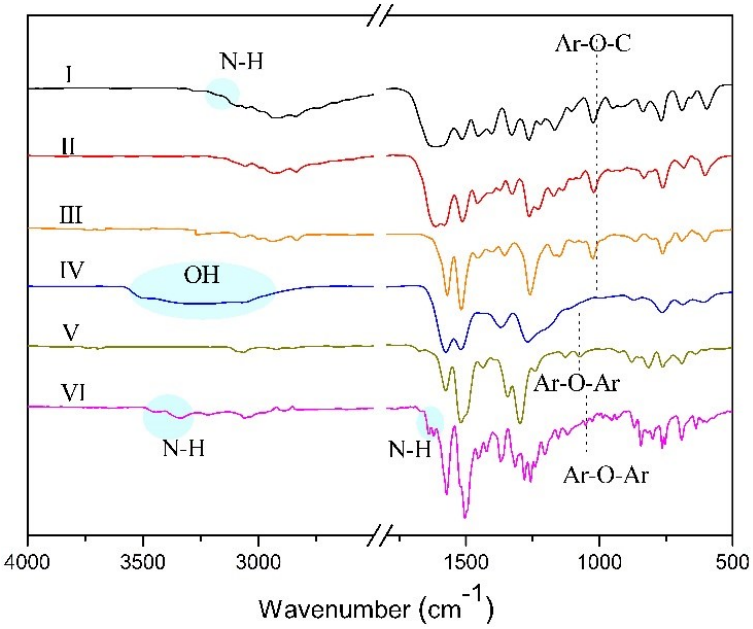

Fig. S2 FTIR spectra of compounds I-VI.

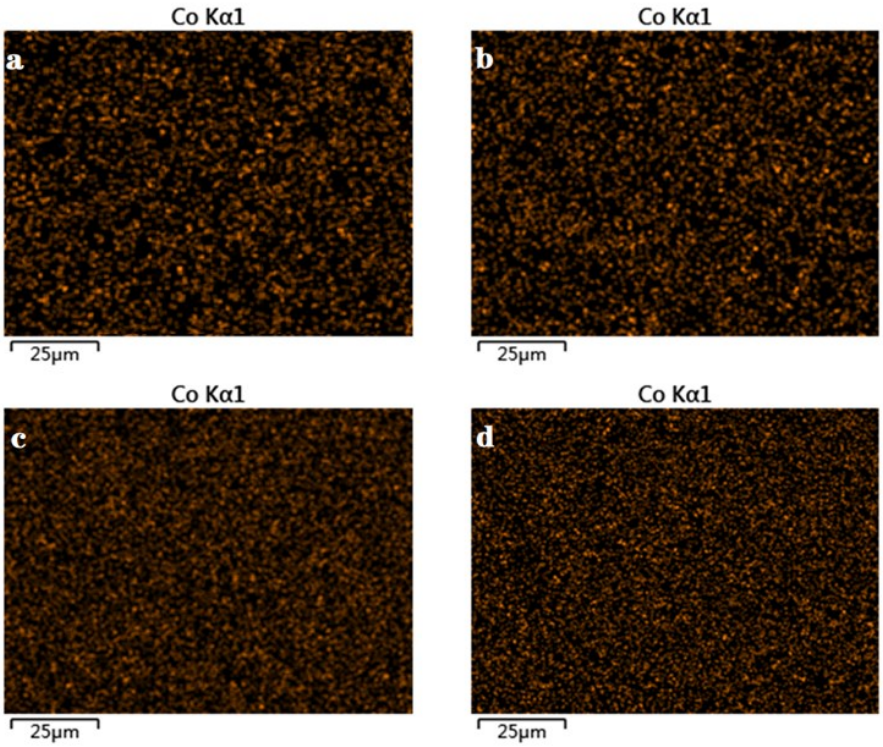

Fig.S3 Surface EDS mapping images: (a) DMD-CPI-3.0, (b) DMD-CPI-10, (c) DMD-CPI-15, (d) DMD-CPI-20.

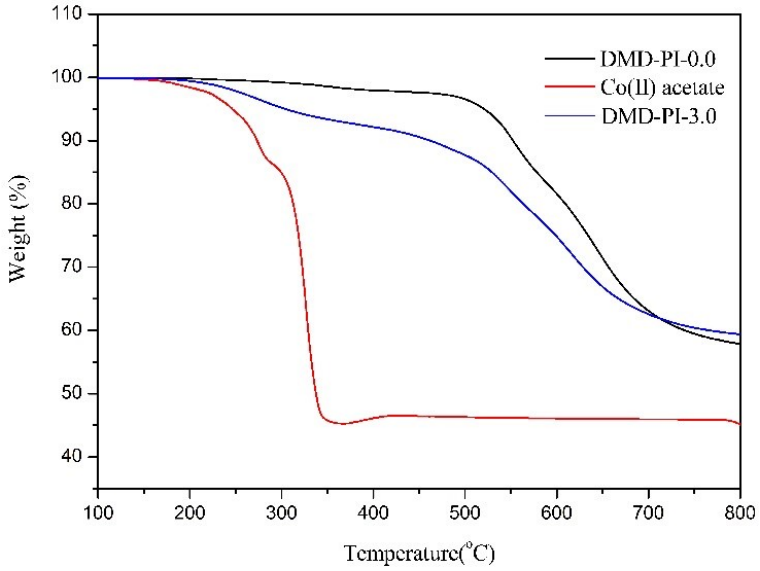

Fig. S4 TGA curves of DMD-PI-0.0, DMD-PI-3.0 and Co(II) acetate in N_2.

The thermal resistance of a membranes can meet the requirements of at elevated temperatures. The thermal performance of DMD-PI-x was estimated by DSC, TGA

from two perspectives. Seen from **Fig. S4**, the 5% weight temperature loss of DMD-PI-0.0 was 519.1°C, and the residual weight retentions at 800°C was 58.01% in N_2. The above proves that DMD-PI-0.0 has remarkable thermal stability. The initial analysis of 2.1% weight loss at 405°C was presumed to be caused by the movement of the segment and the evaporation of excess solvent. In addition, the 2.1% weight loss of dmd-PI-0.0 at 405 °C was initially speculated to be caused by segment movement and volatile residual solvents.

Cobalt acetate mainly decomposes in three steps in nitrogen. As the first step begins to lose weight (loss of crystal water) at 140°C, and the weight loss rate accumulates 13.70%. Step 2 weightlessness is at 290°C. Cobalt acetate first generates cobalt oxalate, then decomposes into Co_3O_4, and eventually becomes CoO, with a cumulative weight loss rate of 86.24%. In the third step, the weight increased by 0.97% from 365oC to 425°C because CoO was re-oxidized to Co_3O_4.

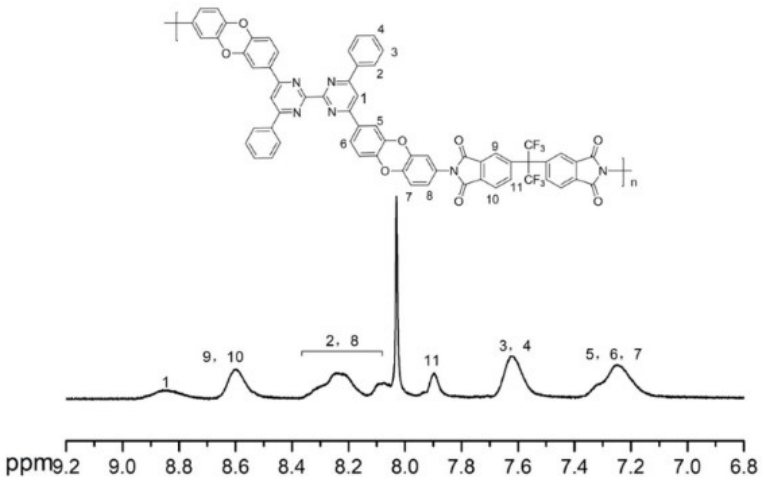

Fig. S5 ^{1}H NMR spectrum of DMD-PI-0.0.

Table.S1 Solubility of DMD-PI-X.

Membranes	CH_3OH	$CHCl_3$	NMP	DMAc	DMF	DMSO
DMD-PI-0.0	-	-	++	++	++	+
DMD-PI-3.0	-	-	+	+	+	-
DMD-PI-10	-	-	-	-	-	-
DMD-PI-15	-	-	-	-	-	-
DMD-PI-20	-	-	-	-	-	-

DMAc is N, N-dimethylacetamide; DMF is N, N-dimethylformamide; NMP is Nmethyl-2-pyrrolidone; DMSO is Dimethyl sulfoxide; DMSO is Dimethyl sulfoxide; $CHCl_3$ is chloroform. ++, soluble at room temperature; +, partial soluble; –, insoluble.

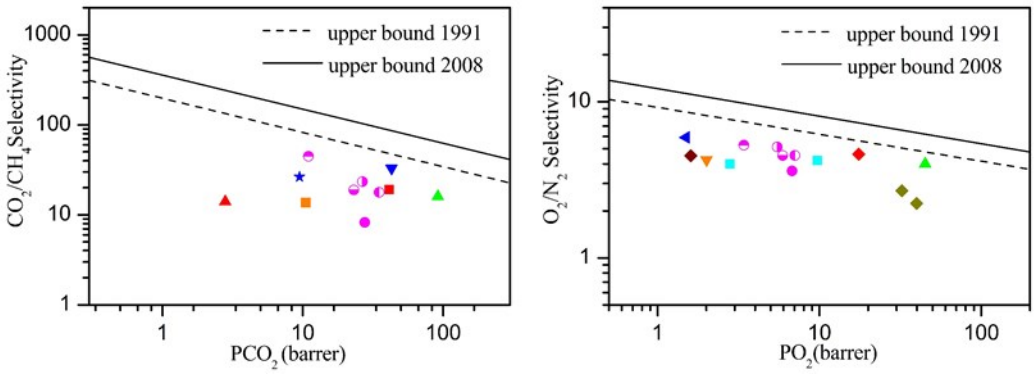

Fig.S6 Robeson's upper-bound relevant to five TCFMs for CO_2/CH_4 and O_2/N_2. The purple circle graphic represents DMD-PI-X (◓: DMD-PI-15,◒: DMD-PI-20,◑: DMD-PI-10,◐: DMD-PI-3.0 ●: DMD-PI-0.0), others are references(▲:[1],★:[2],■:[3],▼:[4], ■:[5],▲:[6],◀:[7],◆:[8],▼:[9],■:[10],◆:[11],◆:[12].)

Table S2 Gas permeability and ideal selectivity of DMD-CPI-15 and other analogous polymer membranes from reference works.

Polymer	**Support layer**	**Filler**	**Gas separation**	**Gas Permeance**	**Selectivity**	**Ref.**
Polyimide[a]	Alumina hydrate	MWCNT	CO_2/CH_4	CO_2: 11 GPU	CO_2/CH_4 = 9	[13]
Polyimide[b]	Carbon support	CMS	O_2/N_2 CO_2/CH_4 CO_2/N_2	O_2: 45 Barrer N_2: 11.2 Barrer	O_2/N_2 = 4 CO_2/CH_4 = 16 CO_2/N_2 = 9	[6]
Polyimide[c]	-	TiO_2	CO_2/CH_4	CO_2: 92 CO_2:15.9 Barrer	CO_2/CH_4=59.6	[14]
Polyimide[d]	-	SiO_2	CO_2/N_2 O_2/N_2	CO_2:0.86 Barrer O_2 : 0.32 Barrer N_2: 0.03 Barrer	CO_2/N_2=28.67 O_2/N_2=11.33	[15]
Polyimide[e]	Alumina	ZIF 8	CO_2/N_2	CO_2:72 GPU N_2: 10 GPU	CO_2/N_2=7.2	[16]
Polyimide[f]	-	$Co(acac)_3$	O_2/N_2	O_2: 14.7 Barrer	O_2/N_2=5.01	[11]
Pebax_1657	PAN	$C60(OH)_{24}$	CO_2/CH_4 CO_2/N_2	CO_2:338 GPU CH_4: 8.24 GPU N_2: 21.1	CO_2/CH_4 = 41 CO_2/N_2 = 16	[17]

				GPU		
Pebax	PVDF	ZIF 8	CO_2/CH_4 CO_2/N_2	CO_2:189 GPU CH_4: 15.75GPU N_2: 8.22 GPU	CO_2/N_2=23 CO_2/CH_4 =12	[18]
Phenolic resin	Alumina	Carbon/SAPO-34	CO_2/CH_4 CO_2/N_2	CO_2: 14 GPU CH_4: 0.28 GPU N2: 0.9 GPU	CO_2/N_2=15.55 CO_2/CH_4 = 50	[19]
Polyimide	Alumina	15wt% $Co(AC)_3$	O_2/N_2 CO_2/CH_4 CO_2N2	O_2: 6.82 GPU N_2: 1.296 GPU CO_2: 21.95 GPU CH_4: 0.49 GPU	O2/N2 = 5.27 CO2/CH4=44.79 CO2/N2 = 28.45	This work

Notes and references

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