**Supporting information**

# Synthesis, Characterization and Gas Permeation Properties of Anthracene Maleimide-Based Polymers of Intrinsic Microporosity

Muntazim Munir Khan [a], Gisela Bengtson [a], Silvio Neumann [a], Md. Mushfequr Rahman [a], Volker Abetz [a,b], Volkan Filiz [a]*

[a] - Helmholtz-Zentrum Geesthacht, Institute of Polymer Research, Max-Planck-Str. 1, 21502 Geesthacht, Germany.

E-mail : volkan.filiz@hzg.de

[b] - University of Hamburg, Institute of Physical Chemistry, Grindelallee 117, 20146 Hamburg, Germany.

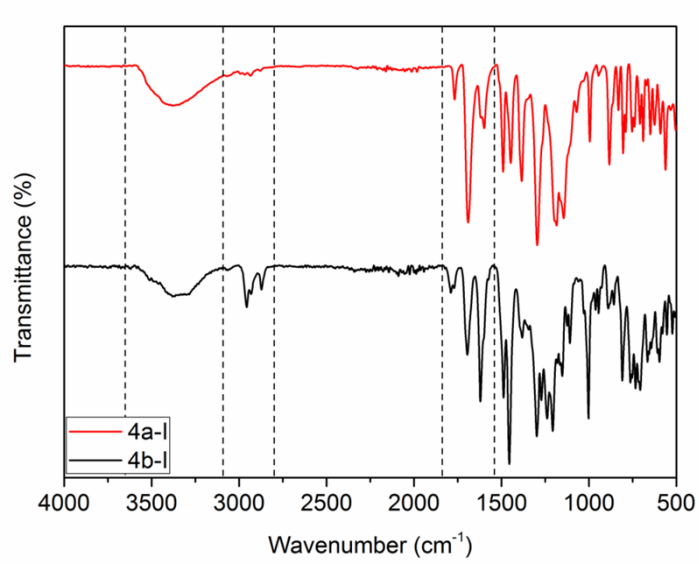



Figure S-1: Comparative FTIR spectra of 4a-1 and 4b-I.

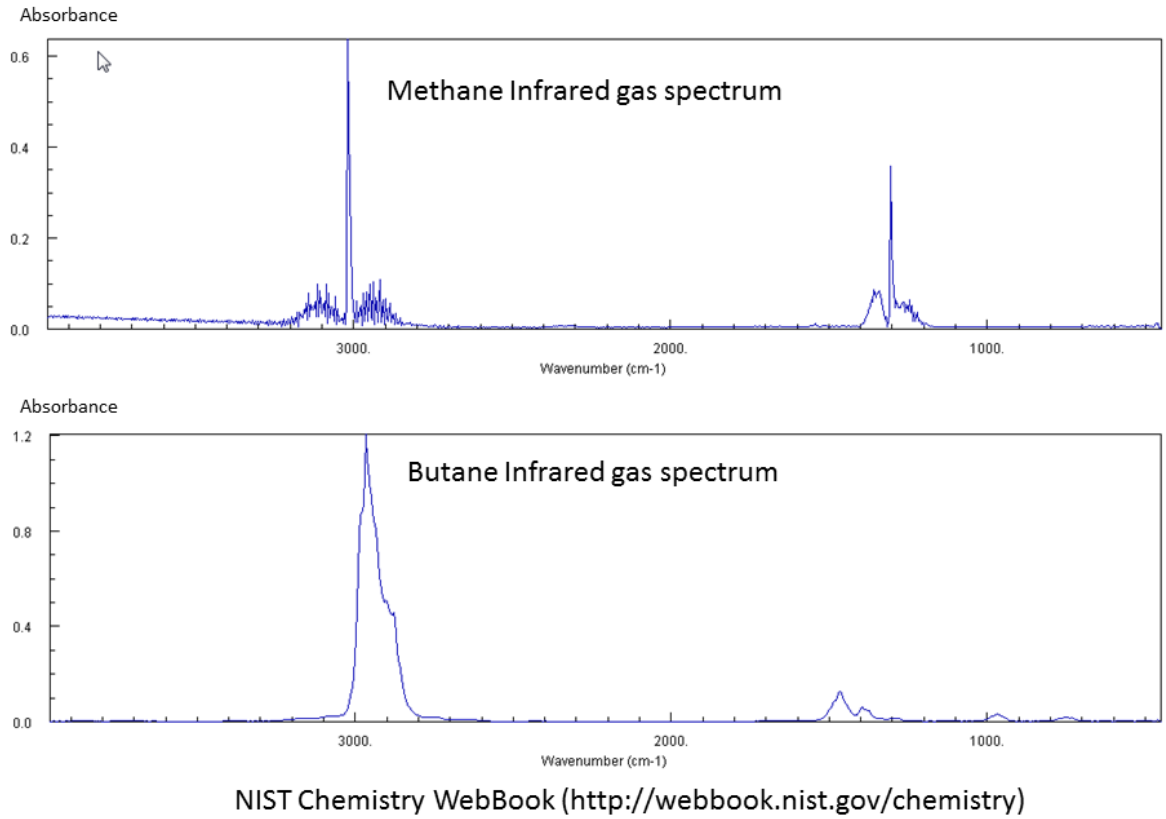



Figure S-2: Reference gas spectra of ~~Methane~~ methane and ~~Butane~~ butane obtained from NIST chemistry WebBook.

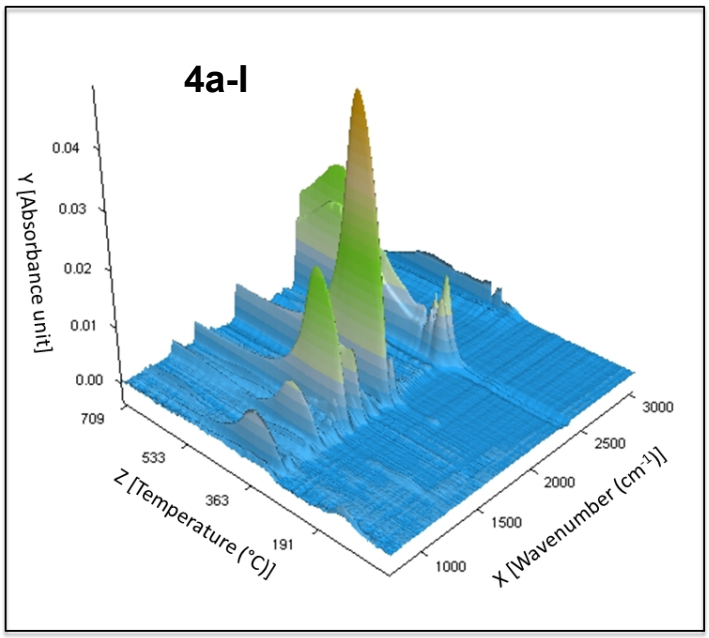



Figure S-3: 3D TGA-FTIR of 4a-I.

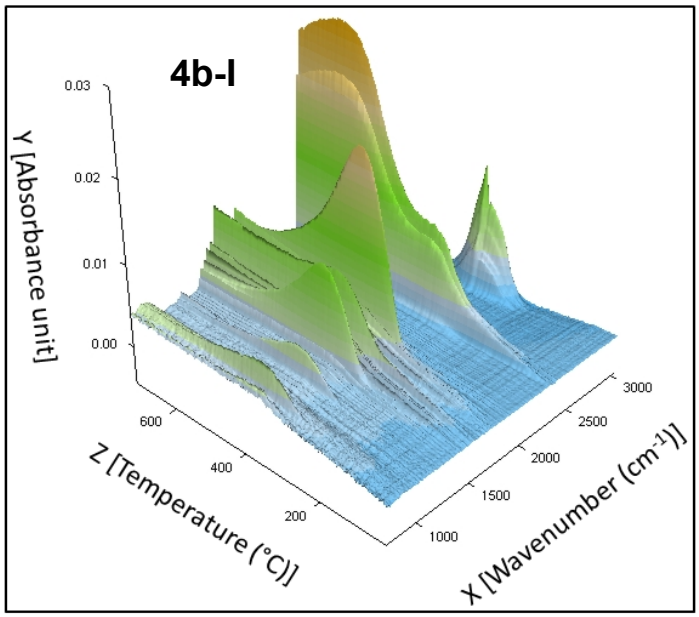



Figure S-4: 3D TGA-FTIR of 4b-I

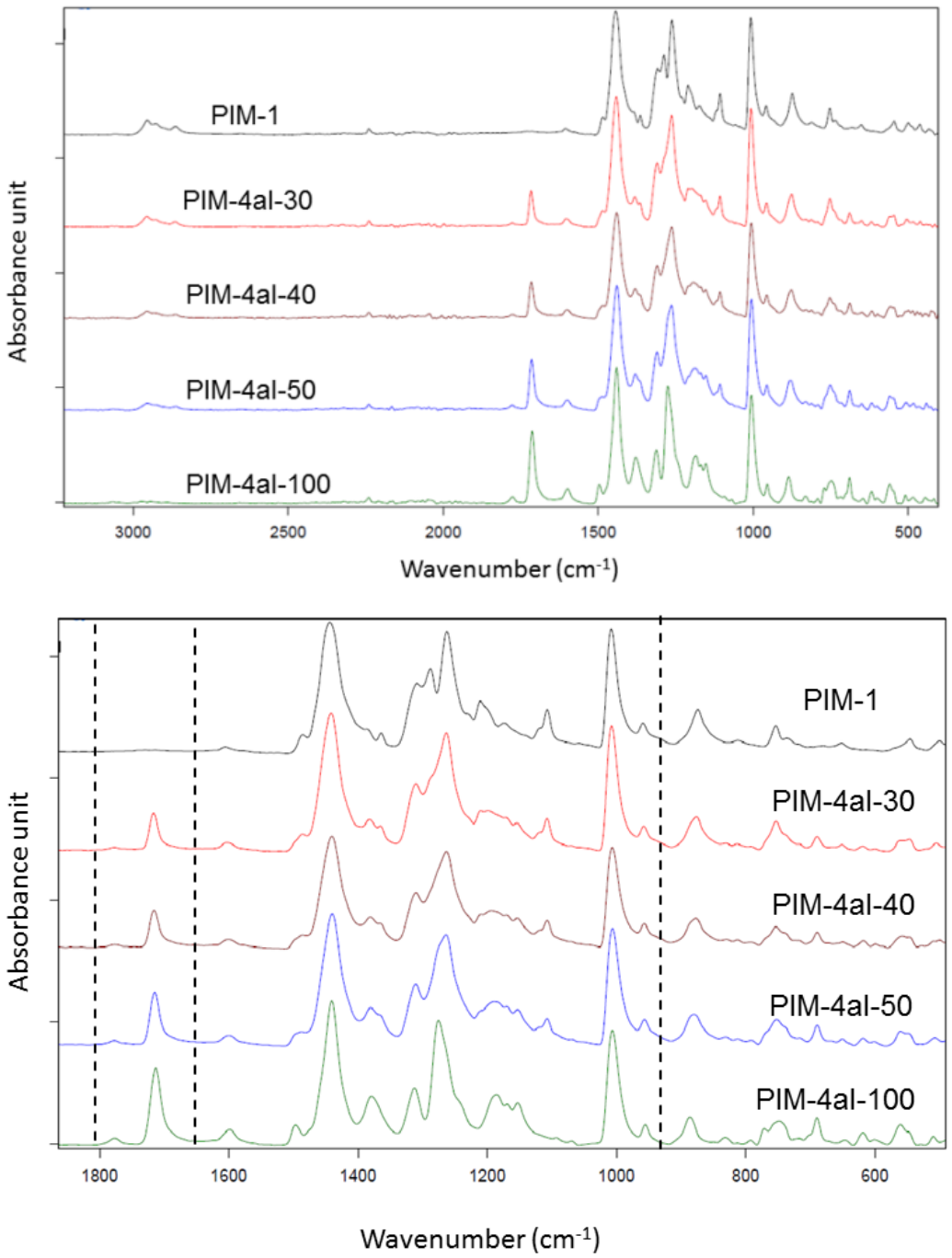



Figure S-5: Comparative FT-IR of copolymer derived from comonomer 4aI.

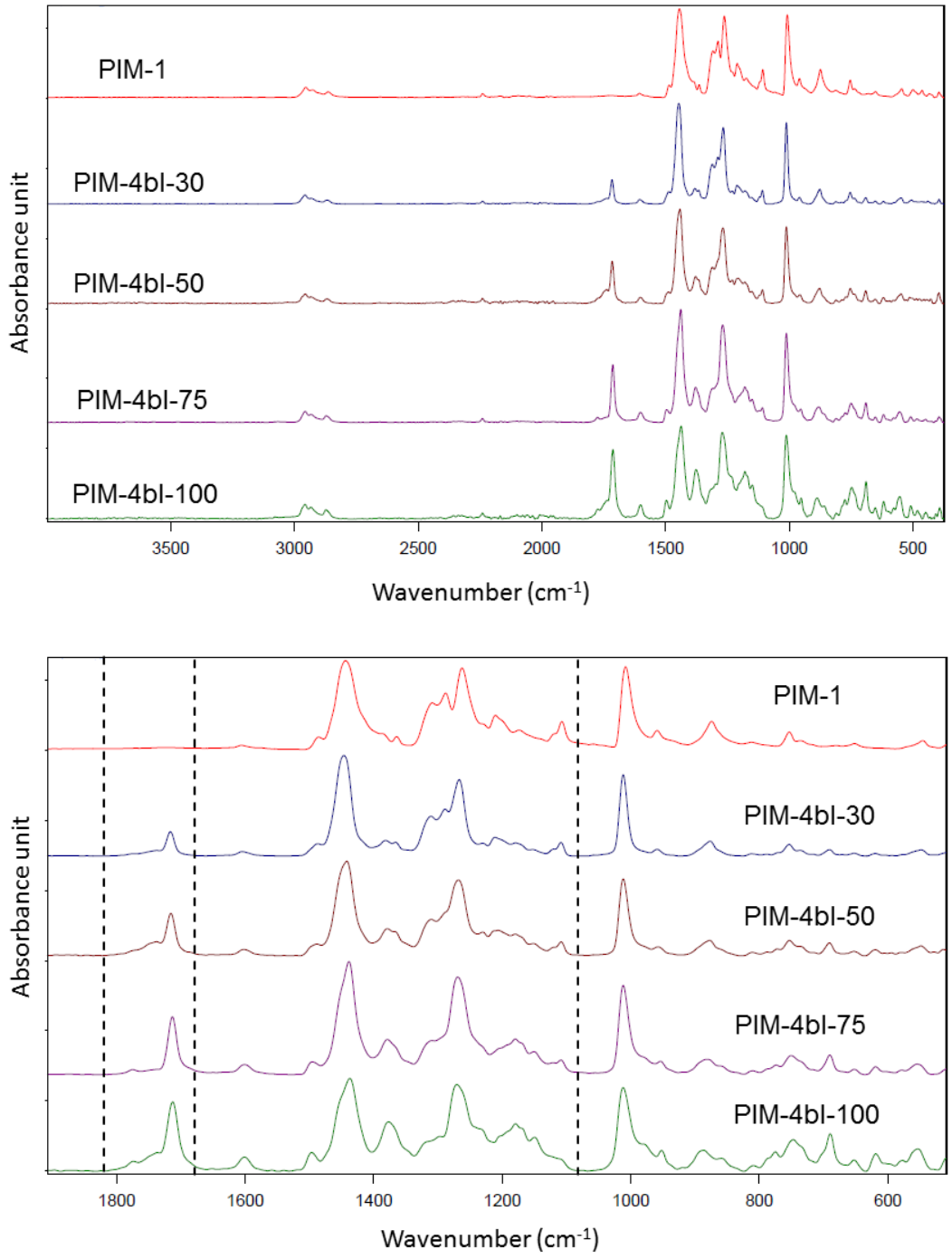



Figure S-6: Comparative FT-IR of copolymer derived from comonomer 4bI.

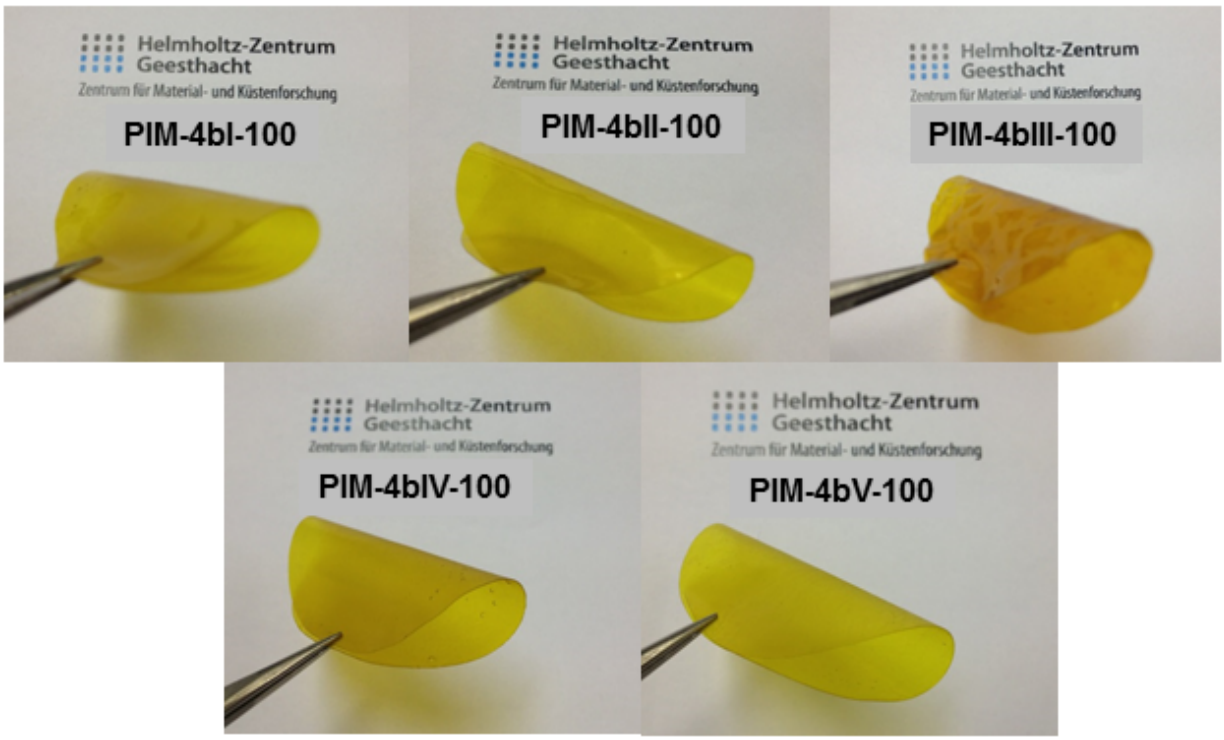



Figure S-7: Time lag films of homopolymers derived from comonomer 4b(I-V).

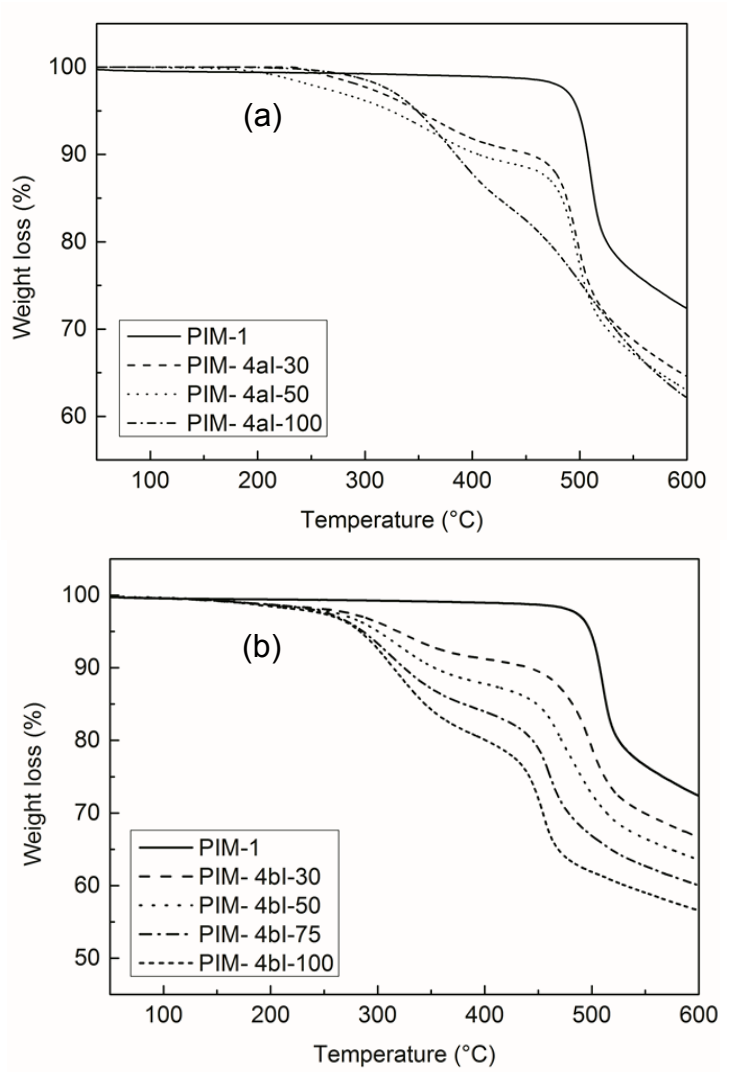
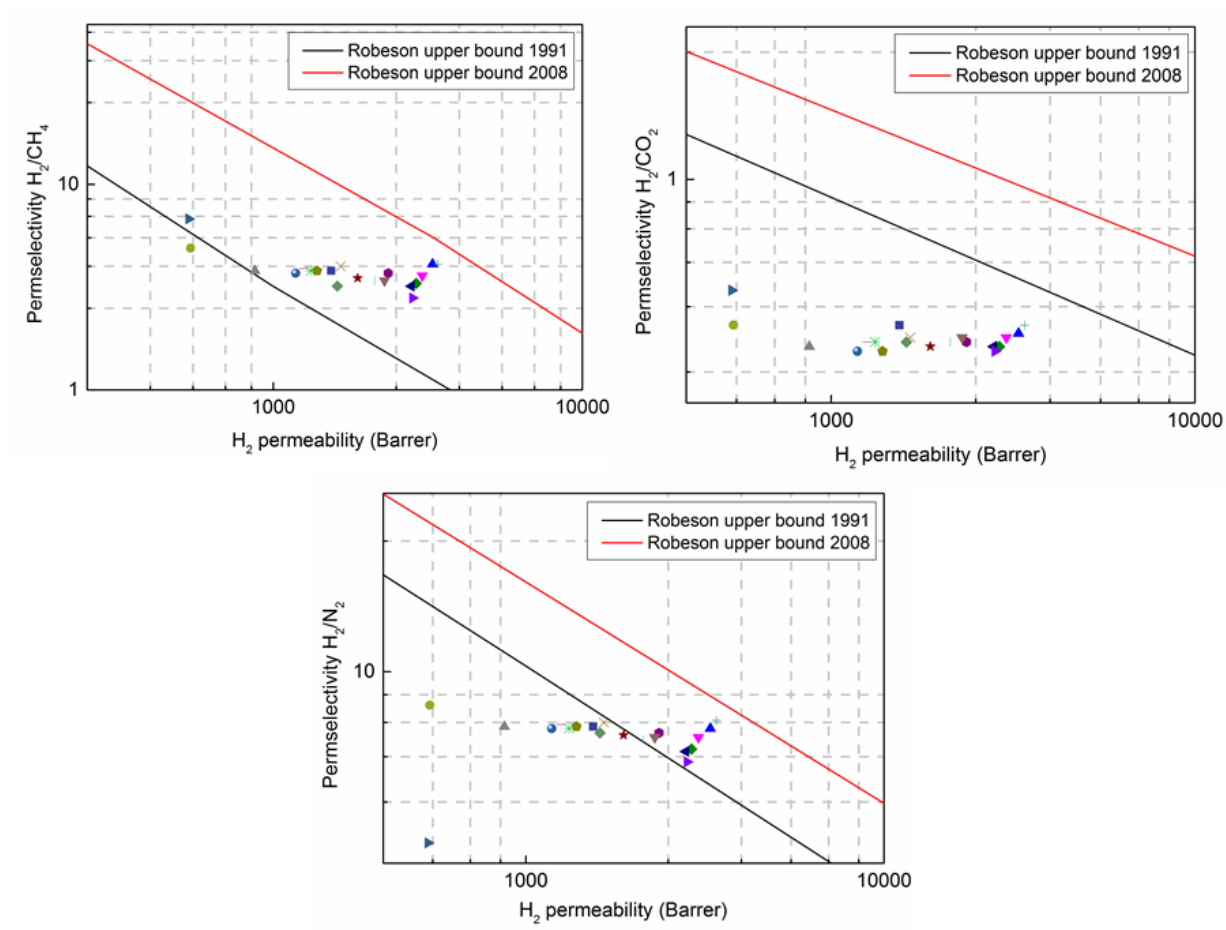



Figure S-8: Comparative TGA spectra of different copolymer composition derived from comonomer (a) 4a-I and (b) 4b-I.




▲ PIM-1[a], ⬢ PIM-4bI-30, ★ PIM-4bI-50, ⬟ PIM-4bI-75, ● PIM-4bI-100, + PIM-4bII-30, × PIM-4bII-50, ✳ PIM-4bII-75, – PIM-4bII-100, ▼ PIM-4bIII-30, ◆ PIM-4bIII-50, ◀ PIM-4bIII-75, ▶ PIM-4bIII-100, ▼ PIM-4bIV-30, ◆ PIM-4bIV-50, ◀ PIM-4bIV-75, ▶ PIM-4bIV-100, | PIM-4bV-30, ■ PIM-4bV-50, ● PIM-4bV-75 ▲ PIM-4bV-100, ⬢ PIM-1[b] [a] - this work ; [b] - Ref.

Figure S-9: Robeson plot for (a) $H_2/CH_4$ (b) $H_2/CO_2$ and (c) $H_2/N_2$ gas pairs showing data for methanol treated PIM-1and CO-PIMs. The black and red lines represent the 1991 and 2008 upper bound, respectively.

| Polymer code | Permeability (Barrer) | | | | |
|---|---|---|---|---|---|
| | $H_2$ | $N_2$ | $O_2$ | $CO_2$ | $CH_4$ |
| PIM-4bI-100 | 1182 | 176 | 465 | 4010 | 316 |
| PIM-4bI-75 | 1385 | 204 | 551 | 4707 | 365 |
| PIM-4bI-50 | 1875 | 291 | 773 | 6308 | 530 |
| PIM-4bI-30 | 2355 | 361 | 981 | 7608 | 641 |
| PIM-4bII-100 | 1255 | 180 | 491 | 4093 | 322 |
| PIM-4bII-75 | 1321 | 196 | 521 | 4233 | 346 |
| PIM-4bII-50 | 1651 | 238 | 642 | 5089 | 401 |
| PIM-4bII-30 | 3404 | 482 | 1328 | 9803 | 828 |
| PIM-4bIII-100 | 2822 | 532 | 1272 | 9772 | 998 |
| PIM-4bIII-75 | 2797 | 490 | 1233 | 9376 | 886 |
| PIM-4bIII-50 | 2902 | 499 | 1279 | 9538 | 883 |
| PIM-4bIII-30 | 3032 | 485 | 1313 | 9519 | 834 |
| PIM-4bIV-100 | 533 | 51 | 158 | 1172 | 78 |
| PIM-4bIV-75 | 1827 | 329 | 769 | 5882 | 622 |
| PIM-4bIV-50 | 1612 | 245 | 758 | 5271 | 510 |
| PIM-4bIV-30 | 2290 | 363 | 956 | 7155 | 669 |
| PIM-4bV-100 | 872 | 127 | 337 | 2900 | 226 |
| PIM-4bV-75 | 540 | 68 | 185 | 1524 | 110 |
| PIM-4bV-50 | 1541 | 225 | 598 | 4689 | 406 |
| PIM-4bV-30 | 2126 | 342 | 881 | 6806 | 634 |
| PIM-1 [a] | 3274 | 483 | 1396 | 9896 | 789 |
| PIM-1 [b] | 3300 | 500 | 1610 | 12600 | 740 |

[a] This work. [b] Ref - [2]

Table S-1: Single gas permeability of PIM-1, homopolymer and copolymer derived from the monomer 4b(I-V).

| Polymer code | Permselectivity | | | | | |
|---|---|---|---|---|---|---|
| | $O_2/N_2$ | $H_2/N_2$ | $H_2/CH_4$ | $H_2/CO_2$ | $CO_2/N_2$ | $CO_2/CH_4$ |
| PIM-4bI-100 | 2.6 | 6.7 | 3.7 | 0.29 | 22.8 | 12.7 |
| PIM-4bI-75 | 3.1 | 6.8 | 3.8 | 0.29 | 22.2 | 12.6 |
| PIM-4bI-50 | 2.6 | 6.4 | 3.5 | 0.30 | 21.7 | 11.9 |
| PIM-4bI-30 | 2.7 | 6.5 | 3.7 | 0.31 | 21.1 | 11.9 |
| PIM-4bII-100 | 2.7 | 6.9 | 3.9 | 0.31 | 22.7 | 12.7 |
| PIM-4bII-75 | 2.6 | 6.7 | 3.8 | 0.31 | 21.6 | 12.2 |
| PIM-4bII-50 | 2.7 | 7.0 | 4.0 | 0.32 | 21.4 | 12.7 |
| PIM-4bII-30 | 2.7 | 7.1 | 4.1 | 0.35 | 20.3 | 11.8 |
| PIM-4bIII-100 | 2.4 | 5.3 | 2.8 | 0.29 | 18.4 | 9.8 |
| PIM-4bIII-75 | 2.5 | 5.7 | 3.2 | 0.3 | 19.1 | 10.6 |
| PIM-4bIII-50 | 2.6 | 5.8 | 3.3 | 0.3 | 19.1 | 10.8 |
| PIM-4bIII-30 | 2.7 | 6.3 | 3.6 | 0.32 | 19.6 | 11.4 |
| PIM-4bIV-100 | 3.1 | 10.4 | 6.8 | 0.45 | 22.9 | 15.0 |
| PIM-4bIV-75 | 2.3 | 5.6 | 2.9 | 0.31 | 17.9 | 9.4 |
| PIM-4bIV-50 | 3.1 | 6.5 | 3.2 | 0.31 | 21.5 | 10.3 |
| PIM-4bIV-30 | 2.6 | 6.3 | 3.4 | 0.32 | 19.7 | 10.7 |
| PIM-4bV-100 | 2.6 | 6.8 | 3.8 | 0.3 | 22.8 | 12.8 |
| PIM-4bV-75 | 2.7 | 7.9 | 4.9 | 0.35 | 22.3 | 13.9 |
| PIM-4bV-50 | 2.6 | 6.8 | 3.8 | 0.35 | 20.8 | 11.5 |
| PIM-4bV-30 | 2.6 | 6.2 | 3.4 | 0.31 | 19.9 | 10.7 |
| PIM-1 [a] | 2.9 | 6.7 | 4.1 | 0.33 | 20.5 | 12.5 |
| PIM-1 [b] | 2.5 | 6.6 | 4.4 | 0.26 | 18.4 | 9.6 |

[a] This work. [b] Ref – [2]

Table S-2: Various gas pairs permselectivity of PIM-1, homopolymer and copolymer derived from the monomer 4b(I-V).