Electronic Supplementary Material (ESI) for Nanoscale Advances.
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# Electronic Supplementary Information (ESI)

# Stable polymeric chain configuration producing high performance PEBAX-1657 membrane for $CO_2$ separation

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**This supplementary data file includes:**

1. Figures S1-S9
2. Tables S1-S3
3. References

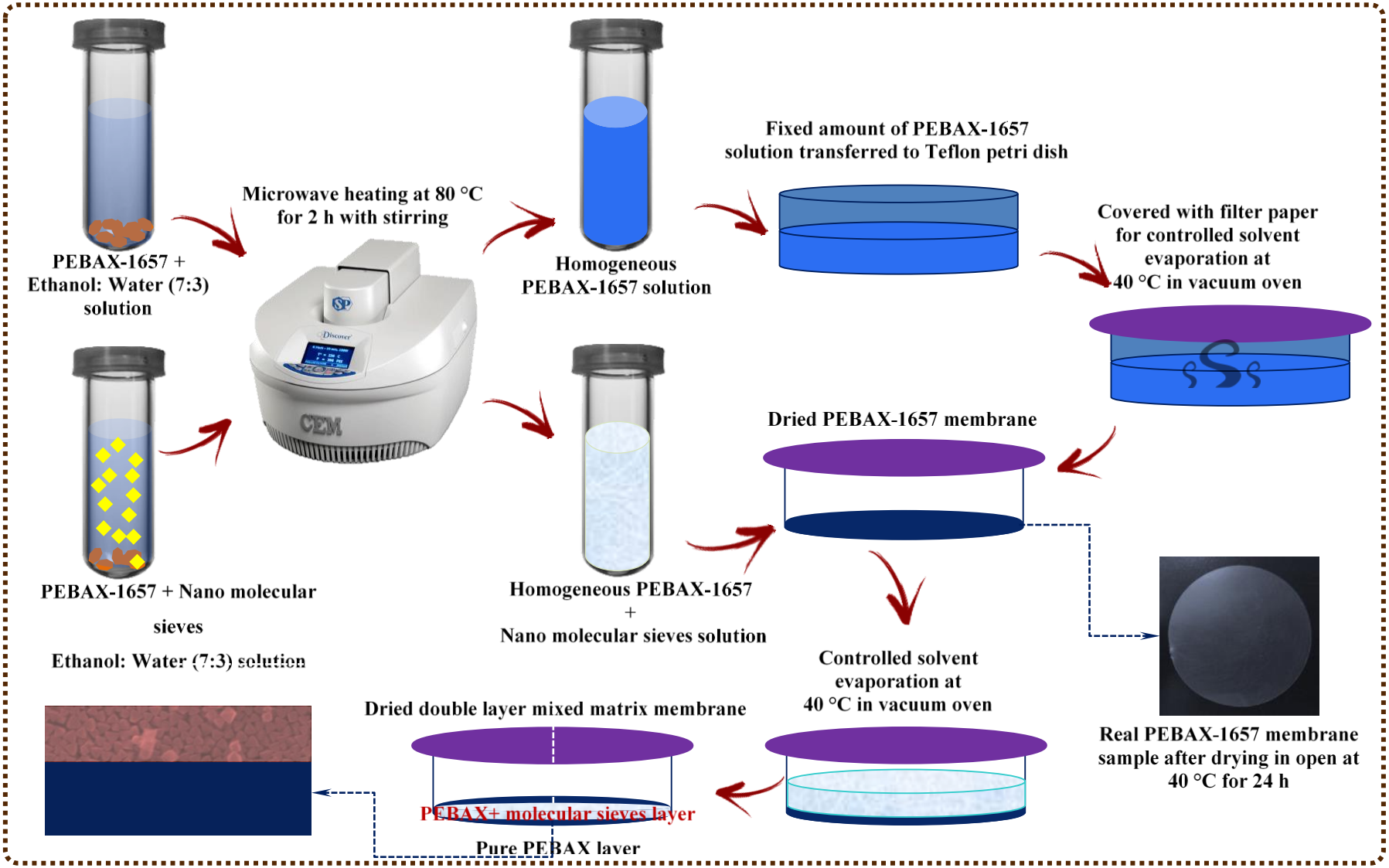


**Fig. S1.** Schematic description of pristine PEBAX and double layer PEBAX/nano molecular sieves MMMs preparation.

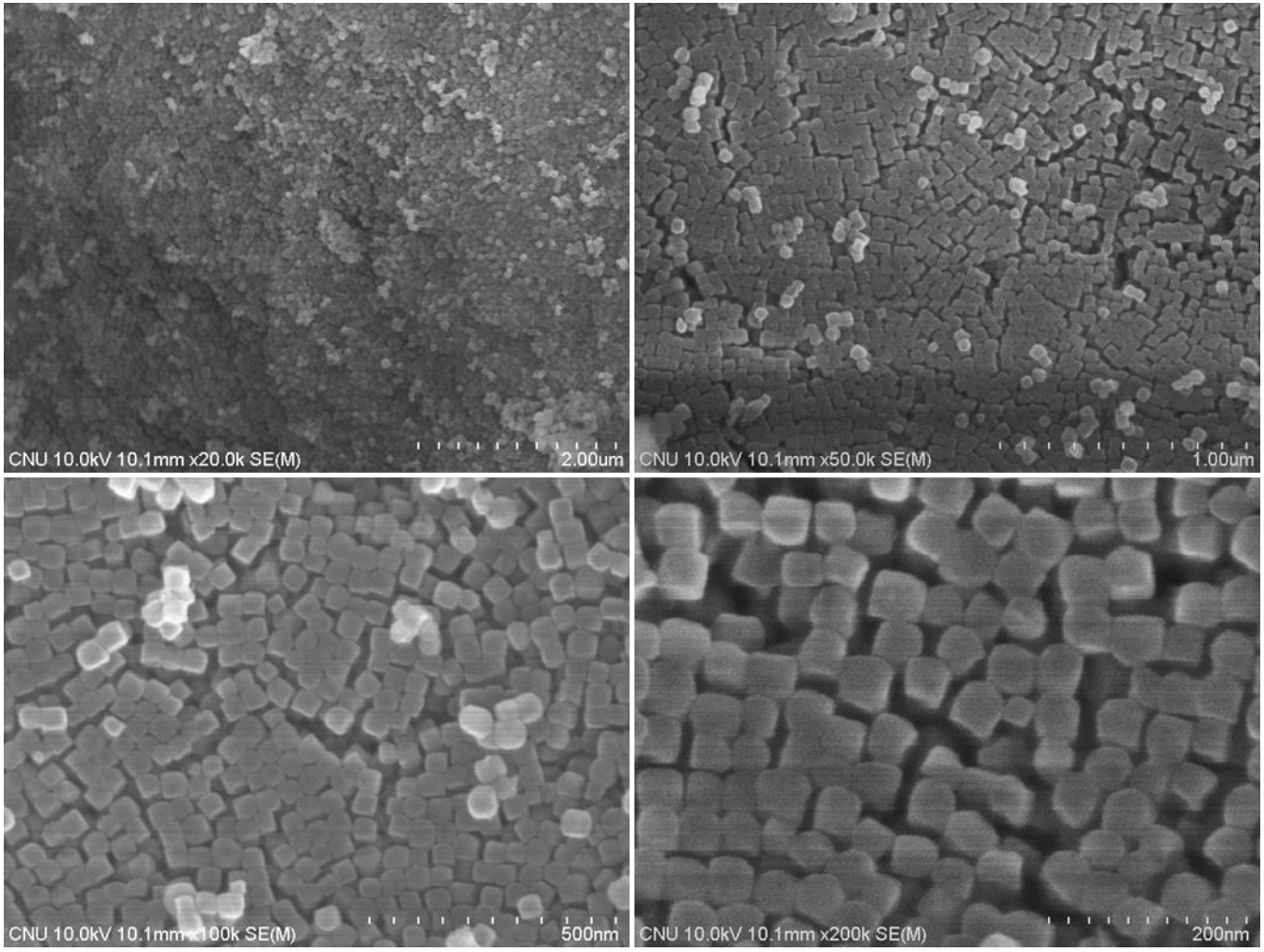


**Fig. S2.** Different magnification scanning electron micrographs of nano size zeolite A molecular sieve crystals.

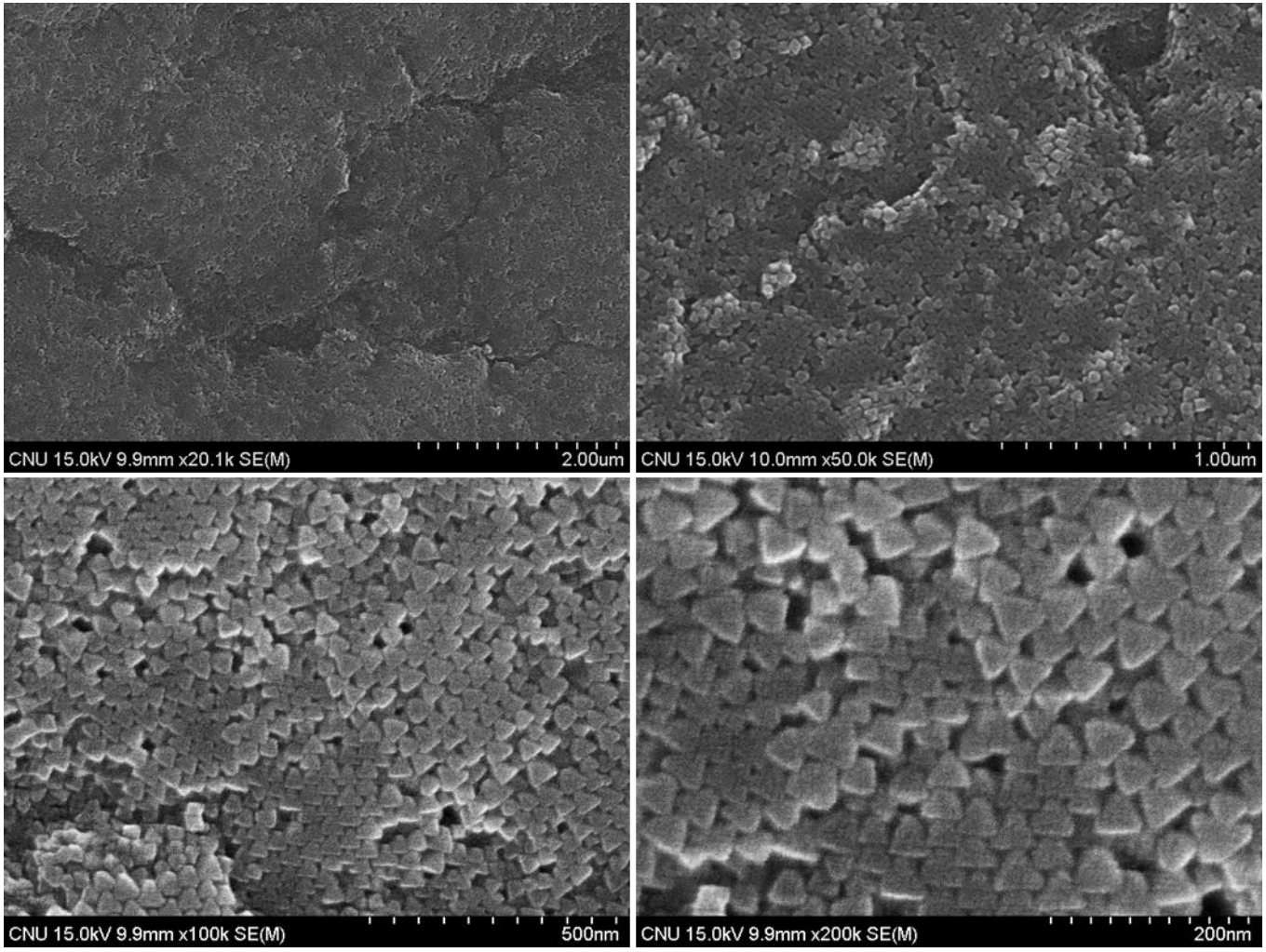


**Fig. S3.** Different magnification scanning electron micrographs of nano size zeolite Y molecular sieve crystals.

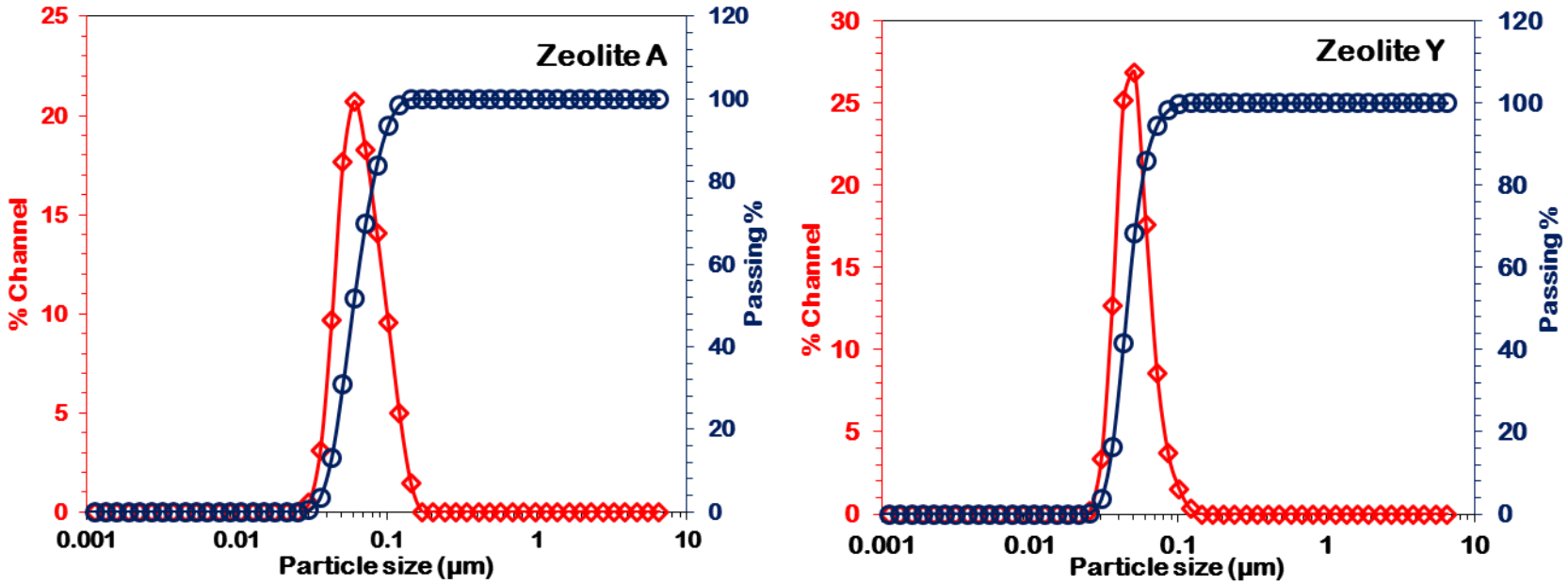


**Fig. S4.** PSD curves of as-synthesized zeolite molecular sieves A and Y.

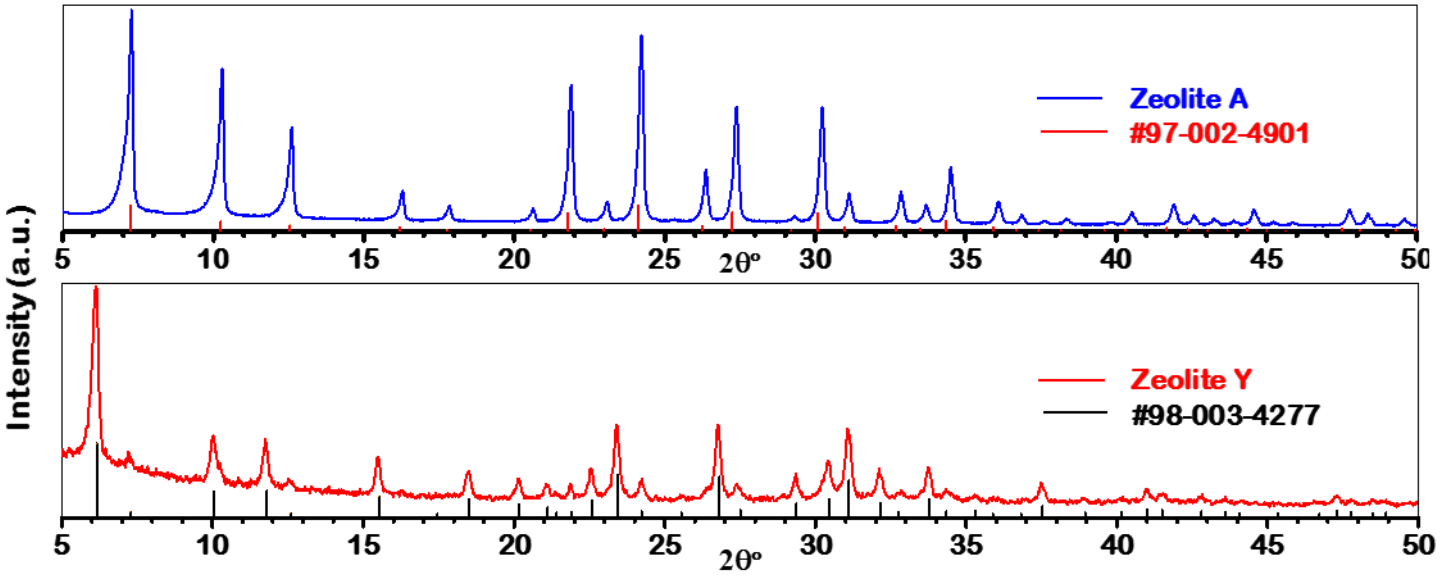


**Fig. S5.** X-ray diffraction patterns of as-synthesized zeolite molecular sieves A and Y along with their respective standard diffraction patterns.

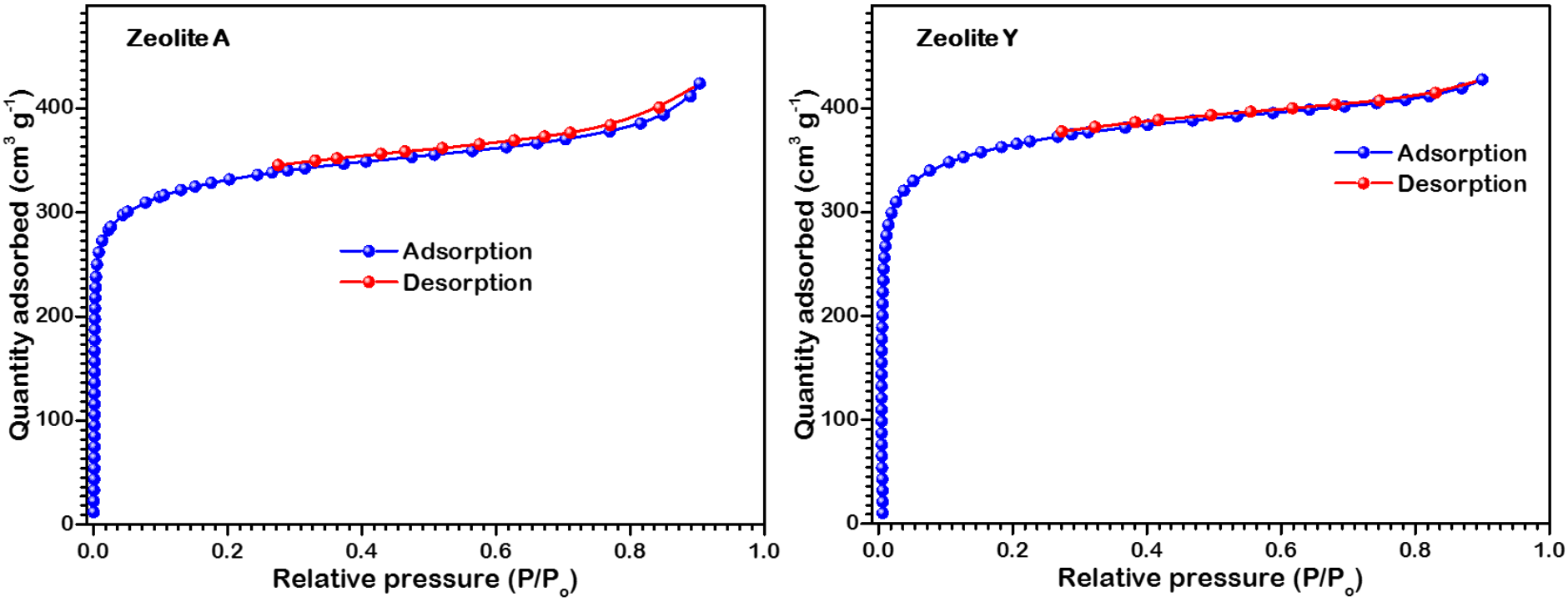


**Fig. S6.** Water vapor adsorption-desorption isotherms of nano size zeolites A and Y molecular sieve crystals at 298 K.

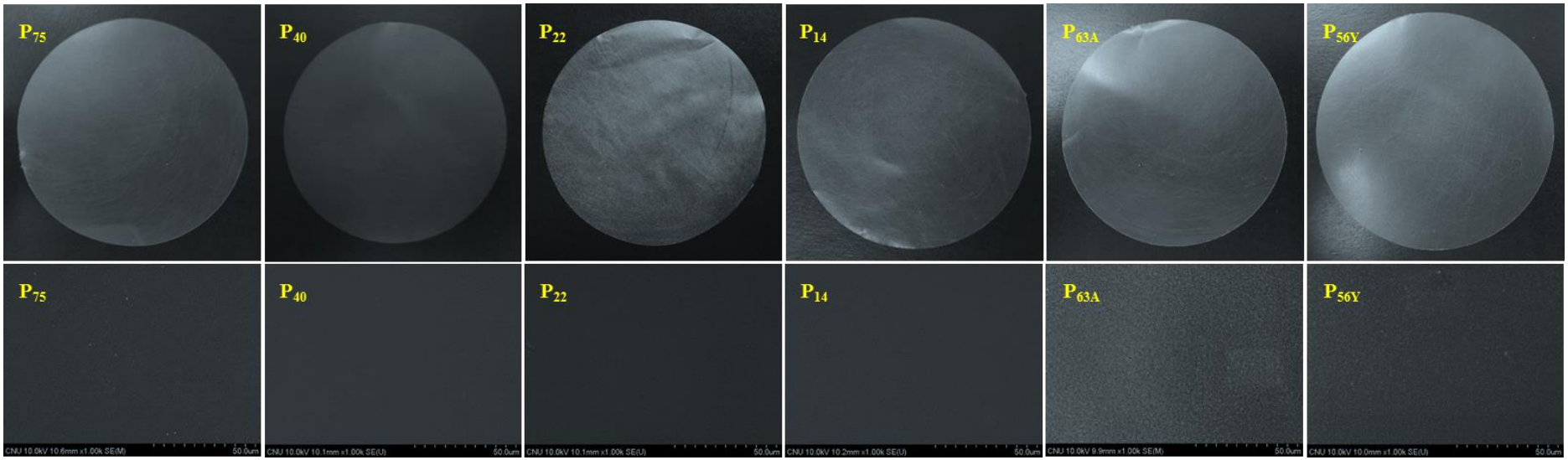


**Fig. S7.** Photographic camera images (top row), and surface SEM micrographs (bottom row) of various thickness PEBAX-1657 membranes.

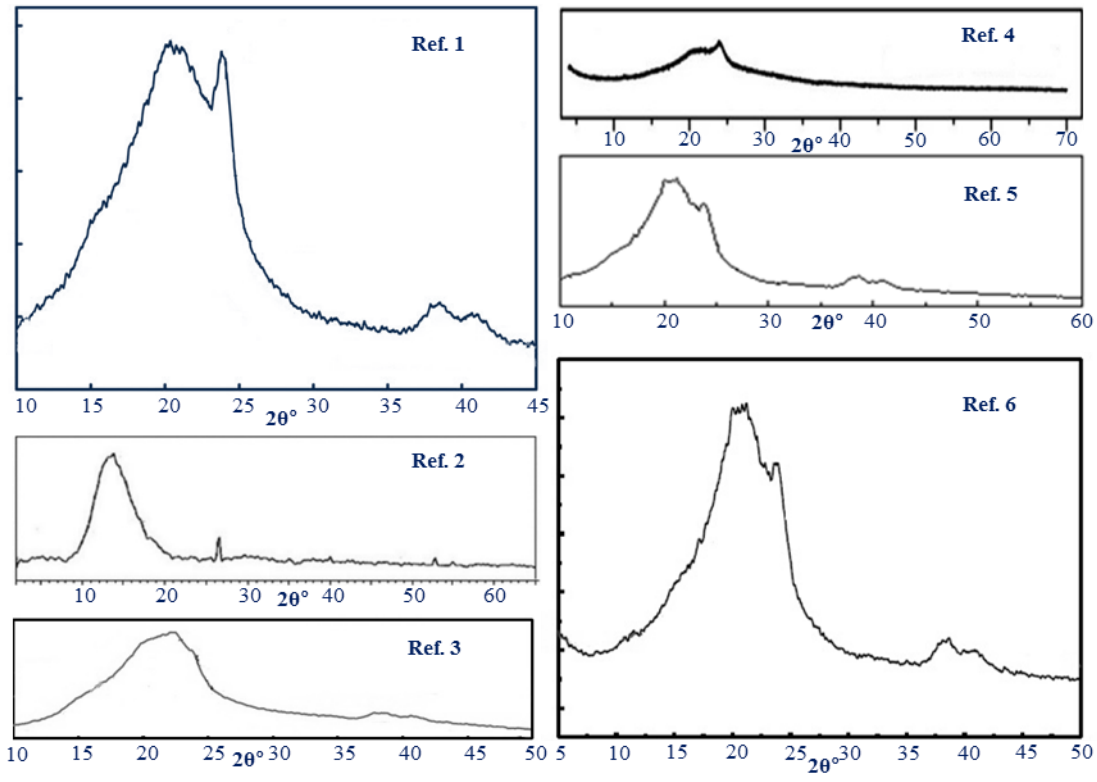


**Fig. S8.** Collective representation of X-ray diffraction patterns of pristine PEBAX-1657 membranes reported in literature to make a healthy comparison with diffraction patterns of the as-synthesized high crystallinity thin PEBAX membranes (**Fig. 4, main text**) (Adopted from ref.[1], and reproduced from refs.[2–6] with permission from the Elsevier).

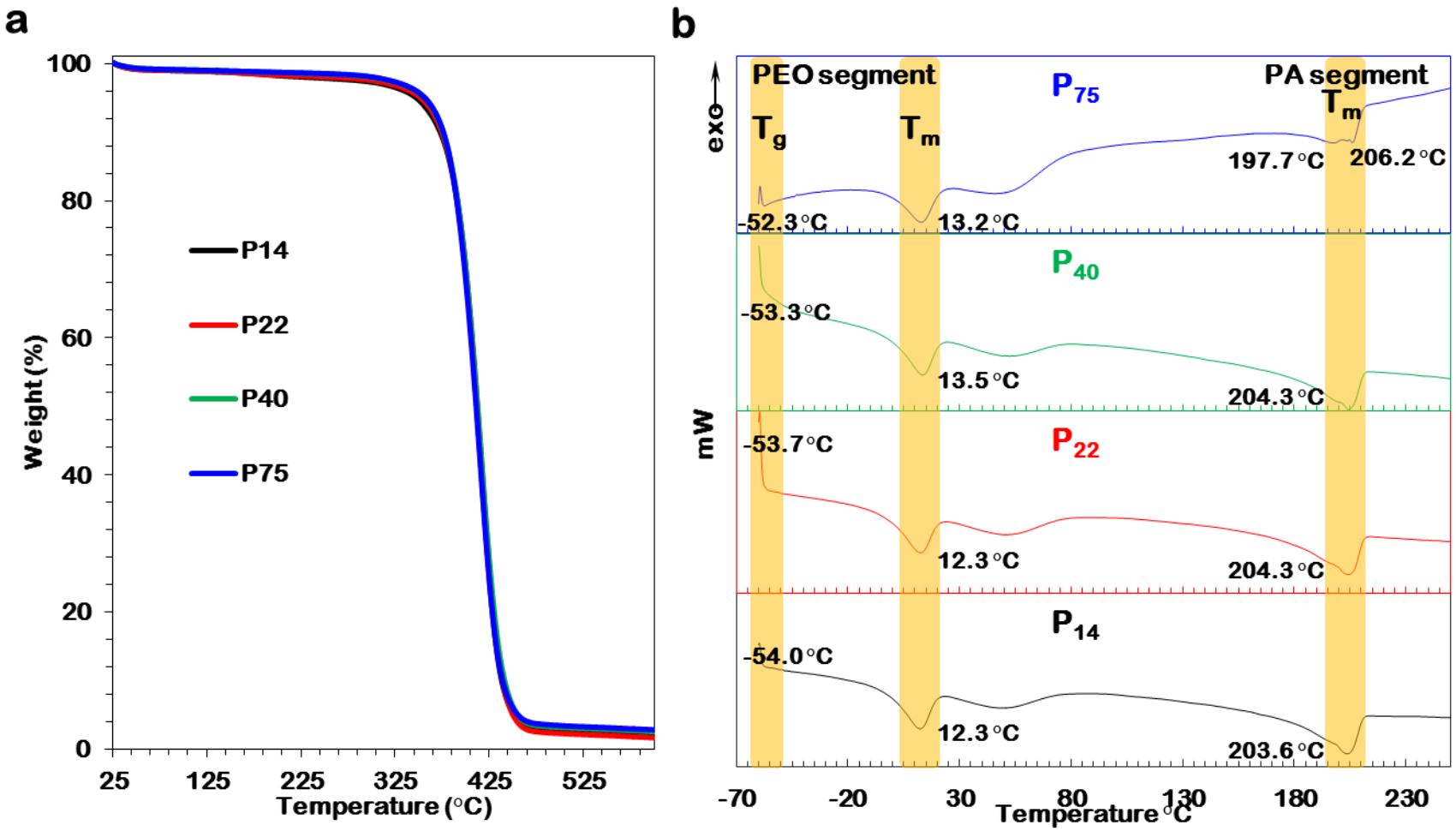


**Fig. S9.** (a) TGA curves, and (b) comparison of DSC profiles of various thickness PEBAX-1657 membranes.

**Table S1.** Textural parameters of zeolite molecular sieves determined by water vapor adsorption-desorption isotherms

| Zeolite | Surface area, $m^2\ g^{-1}$ | Pore volume ($P/P_o$= 0.90), $cm^3\ g^{-1}$ |
|---|---|---|
| NaA | 982.15 | 0.34 |
| NaY | 1093.10 | 0.35 |

**Table S2.** Gas diffusivity and solubility coefficients of the different thickness pure PEBAX membranes

| Membrane | Diffusivity ($cm^2 S^{-1}$) | | | | Selectivity | | | Solubility $x10^{-4}$ ($cm^3$(STP)/$cm^2$.cmHg) | | | | Selectivity | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ | $N_2$ | $O_2$ | $CH_4$ | $CO_2/N_2$ | $CO_2/O_2$ | $CO_2/CH_4$ | $CO_2$ | $N_2$ | $O_2$ | $CH_4$ | $CO_2/N_2$ | $CO_2/O_2$ | $CO_2/CH_4$ |
| $P_{14}$ | $2.60x10^{-6}$ | $9.29x10^{-7}$ | $2.25x10^{-7}$ | $2.88x10^{-7}$ | 2.80 | 11.56 | 9.03 | 65.48 | 3.02 | 35.73 | 33.16 | 21.63 | 1.83 | 1.97 |
| $P_{22}$ | $1.47x10^{-6}$ | $1.81x10^{-6}$ | $1.89x10^{-5}$ | $5.03x10^{-7}$ | 8.12 | 0.78 | 29.22 | 9.73 | 1.46 | 0.41 | 18.85 | 6.65 | 23.85 | 0.52 |
| $P_{40}$ | $1.35x10^{-6}$ | $1.66x10^{-6}$ | $1.01x10^{-6}$ | $4.65x10^{-7}$ | 0.81 | 1.34 | 2.90 | 100.76 | 1.68 | 7.92 | 21.57 | 59.95 | 12.72 | 4.67 |
| $P_{75}$ | $1.21x10^{-6}$ | $7.28x10^{-7}$ | $7.63x10^{-7}$ | $4.12x10^{-7}$ | 1.66 | 1.59 | 2.94 | 70.37 | 3.31 | 8.62 | 20.19 | 21.26 | 8.16 | 3.48 |
| $P_{63A}$ | $8.07x10^{-7}$ | $2.67x10^{-7}$ | - | $2.93x10^{-7}$ | 3.02 | - | 2.75 | 67.31 | 5.77 | - | 17.99 | 11.67 | - | 3.74 |
| $P_{56Y}$ | $1.24x10^{-6}$ | $4.23x10^{-7}$ | $1.26x10^{-6}$ | $5.77x10^{-7}$ | 2.93 | 0.98 | 2.15 | 93.64 | 8.32 | 9.13 | 19.36 | 11.25 | 10.25 | 4.84 |

**Table S3.** Comparison of literature reported pure PEBAX as well as MMM with as synthesize different thickness pure PEBAX membranes

| Membrane | $P_{CO_2}$, Barrer | Selectivity | | | T, °C | Pressure, bar | Polymer Wt.% | Membrane thickness, µm | Ref. |
|---|---|---|---|---|---|---|---|---|---|
| | | $CO_2/N_2$ | $CO_2/O_2$ | $CO_2/CH_4$ | | | | | |
| PEBAX | 80.0 | 49.0 | - | - | 30.0 | 1 | 3.0 | - | [7] |
| PEBAX-40% PEG-GDMS-POSS-THF | 160.0 | 40.4 | - | - | 30.0 | 1 | 3.0 | - | [7] |
| PEBAX | 80.0 | 70.0 | - | - | 21.0 | 2.3 | 7.5 | 50.0-90.0 | [8] |
| PEBAX-30% PS colloid | 44.0 | 66.0 | - | - | 21.0 | 2.3 | 7.5 | 50.0-90.0 | [8] |
| PEBAX-5% SWNT | 102.0 | 73.0 | - | - | 21.0 | 2.3 | 7.5 | 50.0-90.0 | [8] |
| PEBAX | 55.8 | 40.2 | 11.8 | 18.0 | 25.0 | 24.5 | 4.0 | - | [2] |
| PEBAX-10% 4A zeolite | 97.0 | 54.0 | 12.4 | 26.5 | 25.0 | 24.5 | 4.0 | - | [2] |
| PEBAX | 88.4 | 49.4 | - | 20.4 | 25.0 | 2 | 4.5 | 80.0-100.0 | [3] |
| PEBAX-2% MWCNT | 119.3 | 51.5 | - | 17.6 | 25.0 | 2 | 4.5 | 80.0-100.0 | [3] |
| PEBAX | 56.0 | 40.0 | - | - | 35.0 | 4 | 10.0 | 25.0 | [4] |
| PEBAX-2% ATP | 77.0 | 52.0 | - | - | 35.0 | 4 | 10.0 | 30.0 | [4] |
| PEBAX | 70.3 | 63.9 | - | 18.5 | 25.0 | 2 | 6.0 | - | [9] |
| PEBAX-30% TEOS | 41.8 | 64.3 | - | 16.1 | 25.0 | 2 | 6.0 | - | [9] |
| PEBAX | 115.0 | 48.0 | - | 18.0 | 30.0 | 2 | 3.0 | 65.0-85.0 | [5] |
| PEBAX-Pro(Silica) | 161.5 | 82.8 | - | 65.5 | 25.0 | 1 | 3.0 | 65.0-85.0 | [5] |
| $P_{14}$ | 184.7 | 59.7 | 22.6 | 18.0 | 25.0 | 2.7 | 2.5 | 14.0 | This work |

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