# *Supporting Information*

# Rapid Microwave-assisted Synthesis of Hybrid Zeolitic-Imidazolate Frameworks with Mixed Metals and Mixed Linkers

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## 1. Mixed metal CoZn-ZIF-8

**Table S1.** Neutron Activation Analysis for the mixed metal CoZn-ZIF-8

| | Mol% Co in synthesis solution | Mol% Co incorporated into framework* |
|---|---|---|
| Co0.20Zn0.80-ZIF-8 | 20 mol% | 18 mol% |
| Co0.33Zn0.67-ZIF-8 | 33 mol% | 30 mol% |
| Co0.50Zn0.50-ZIF-8 | 50 mol% | 45 mol% |
| Co0.67Zn0.33-ZIF-8 | 67 mol% | 64 mol% |
| Co0.80Zn0.20-ZIF-8 | 80 mol% | 79 mol% |

*with respect to total metal

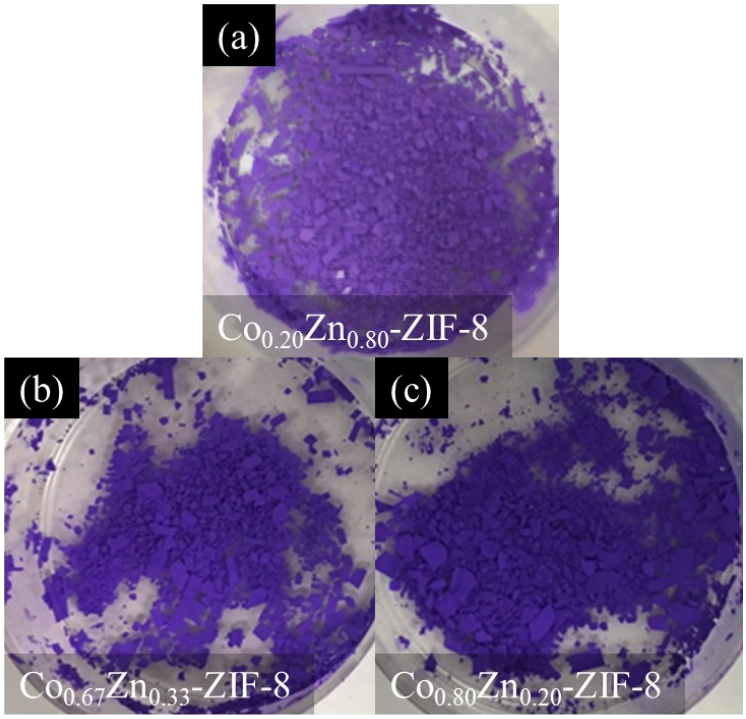


**Figure S1.** Photographs of (a) $Co_{0.20}Zn_{0.80}$-ZIF-8, (b) $Co_{0.67}Zn_{0.33}$ZIF-8, (c) $Co_{0.80}Zn_{0.20}$ZIF-8.

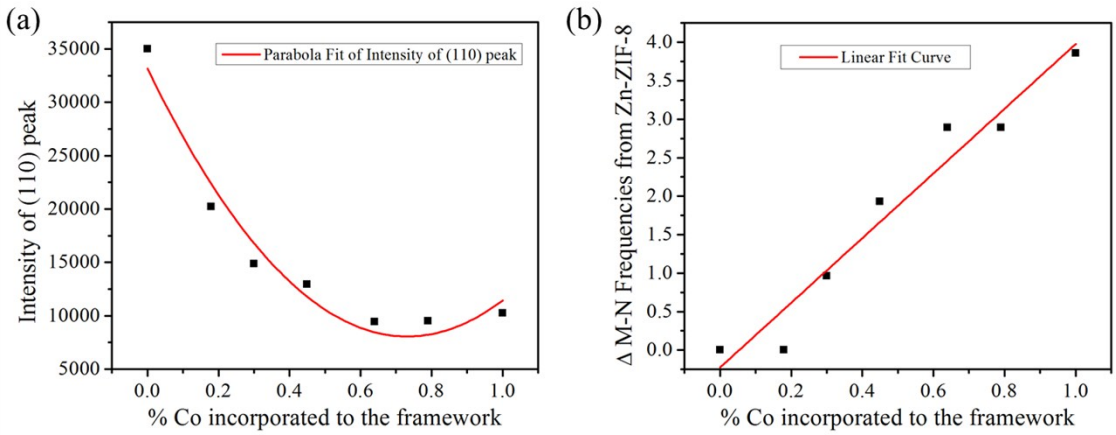


**Figure S2.** Relationship between % Co incorporated to the framework with (a) intensity of (110) peak, and (b) M-N stretching frequencies blue shift from the pure Zn-ZIF-8.

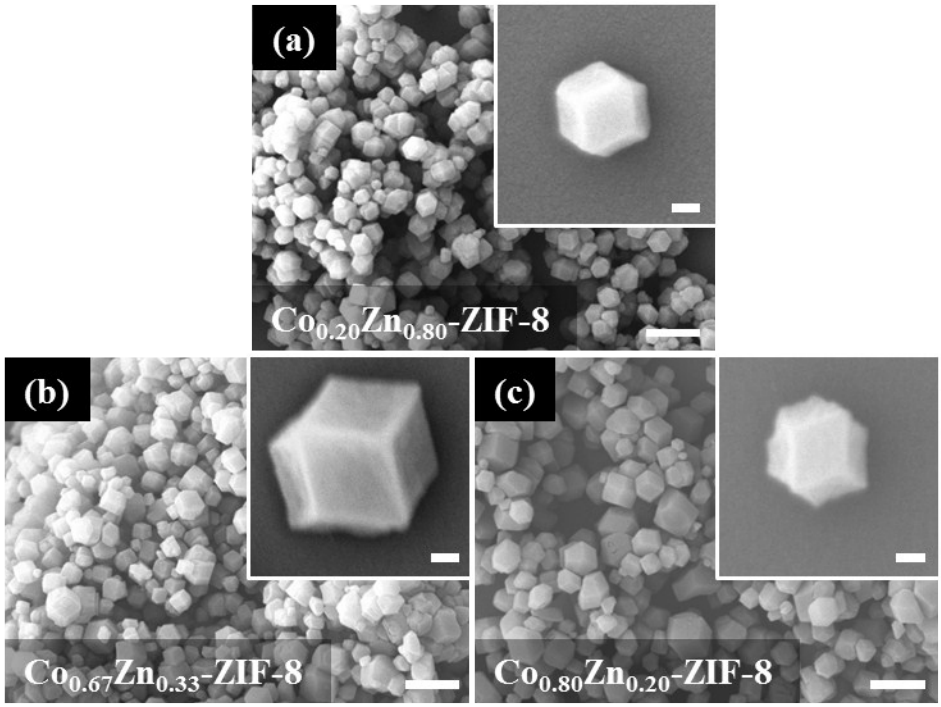


**Figure S3.** Scanning electron microscopy (SEM) images of (a) $Co_{0.20}Zn_{0.80}$-ZIF-8, (b) $Co_{0.67}Zn_{0.33}$ZIF-8, (c) $Co_{0.80}Zn_{0.20}$ZIF-8. All scale inside the white box is 100 nm, and outside white box is 1 μm

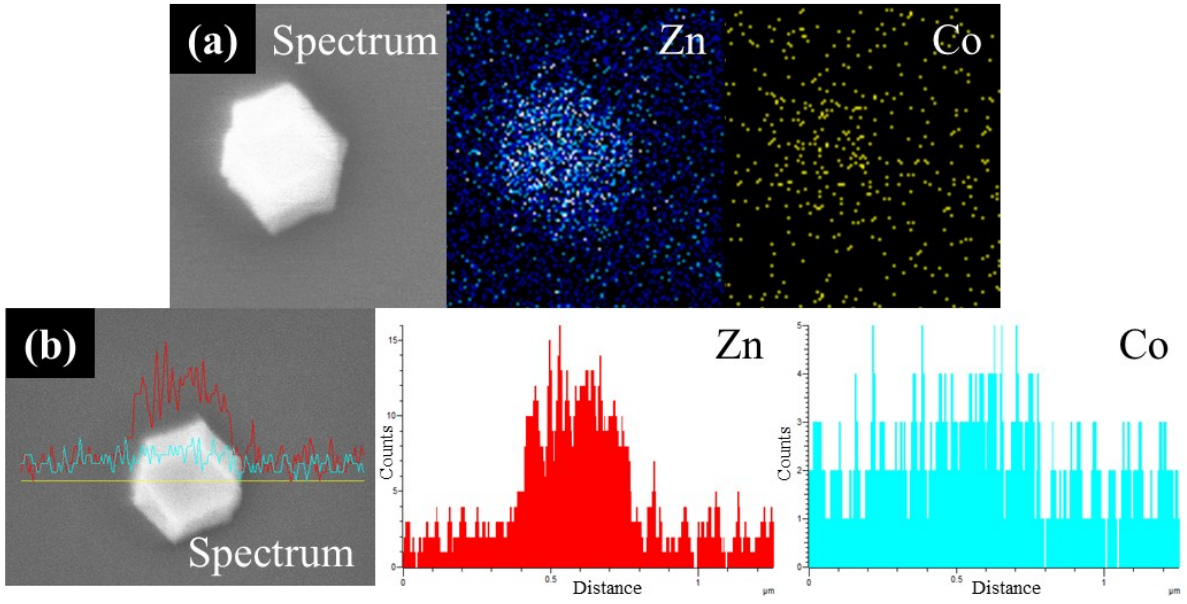


**Figure S4.** SEM-EDS profile for $Co_{0.20}Zn_{0.80}$-ZIF-8 crystal using (a) elemental mapping method, and (b) line scanning method where yellow line in the SEM picture indicate the EDS analysis area.

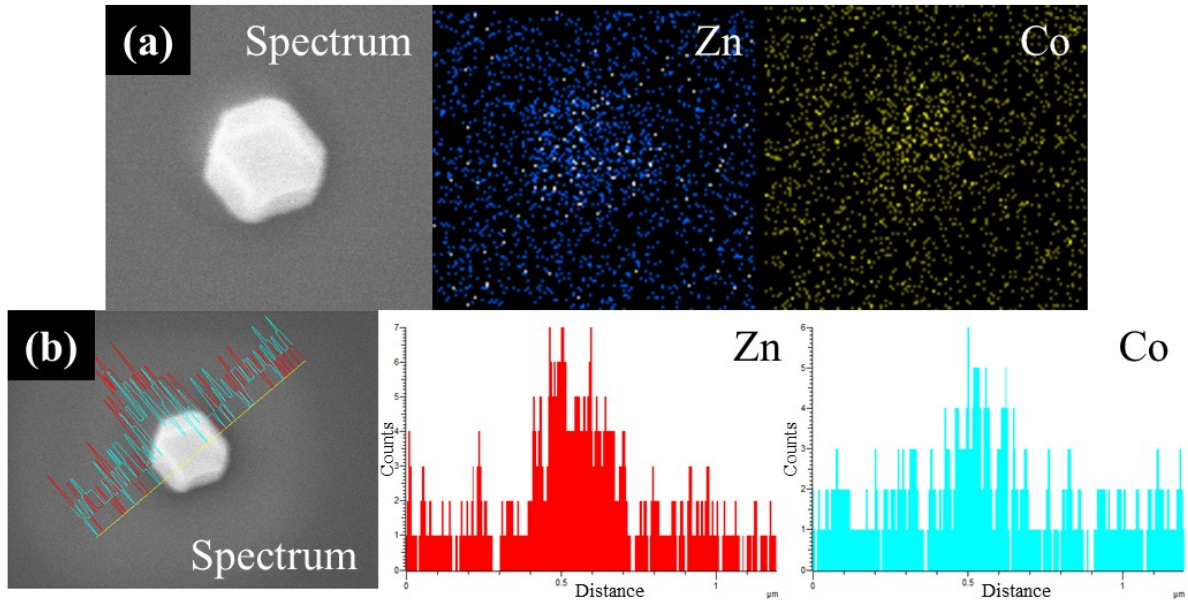


**Figure S5.** SEM-EDS profile for $Co_{0.33}Zn_{0.67}$-ZIF-8 crystal using (a) elemental mapping method, and (b) line scanning method where yellow line in the SEM picture indicate the EDS analysis area.

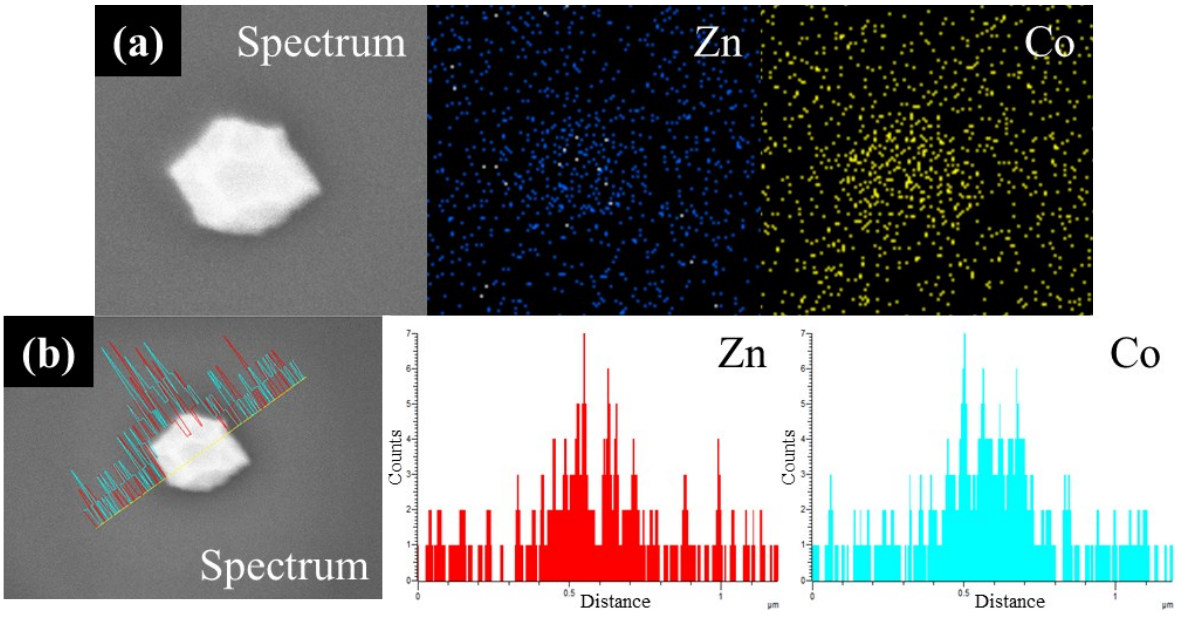


**Figure S6.** SEM-EDS profile for $Co_{0.67}Zn_{0.33}$-ZIF-8 crystal using (a) elemental mapping method, and (b) line scanning method where yellow line in the SEM picture indicate the EDS analysis area.

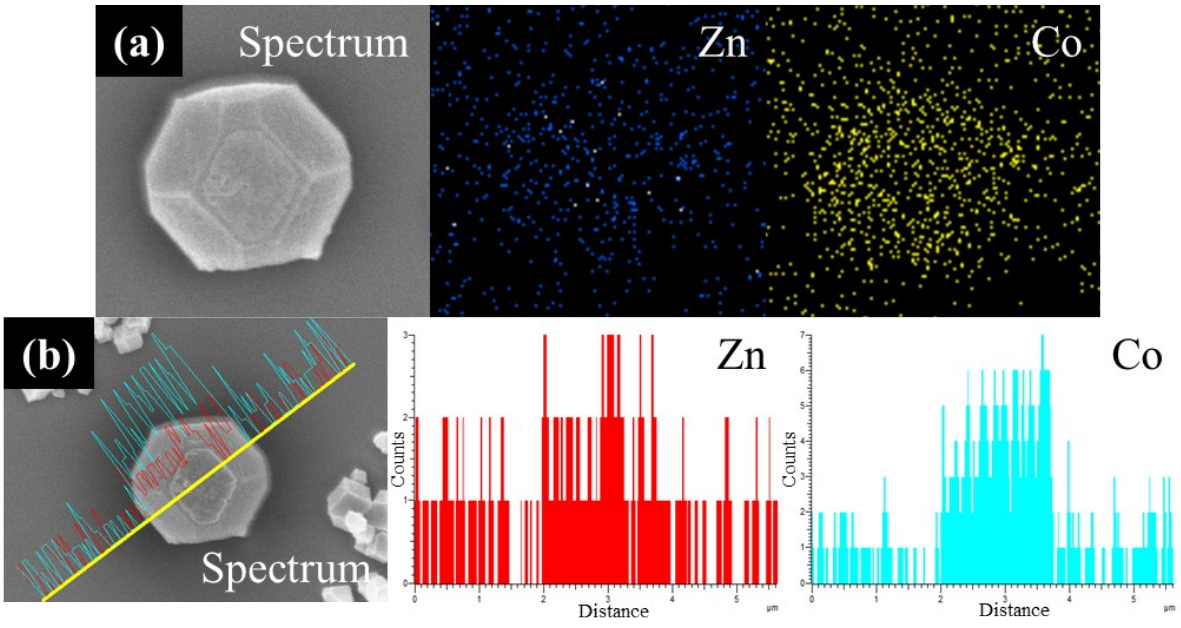


**Figure S7.** SEM-EDS profile for $Co_{0.80}Zn_{0.20}$-ZIF-8 crystal using (a) elemental mapping method, and (b) line scanning method where yellow line in the SEM picture indicate the EDS analysis area.

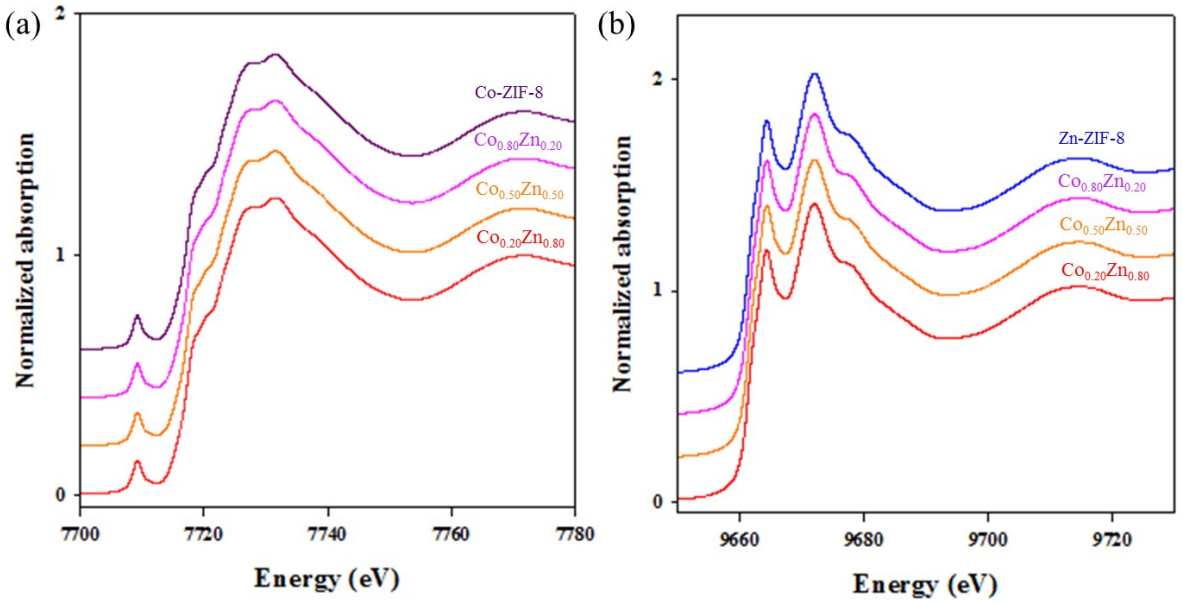


**Figure S8.** (a) Co K-edge XANES spectra for Co-ZIF-8 and CoZn-ZIF-8; (b) Zn K-edge XANES spectra for Zn-ZIF-8 and CoZn-ZIF-8.

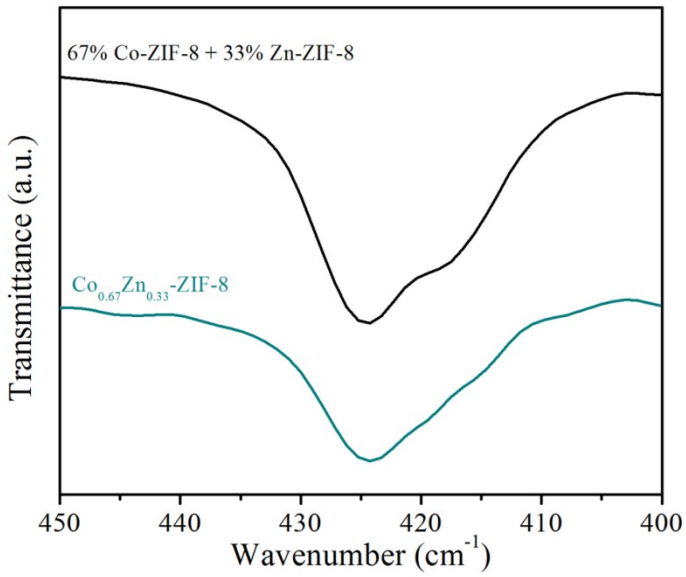


**Figure S9.** FT-IR spectra comparing M-N stretching vibration from hybrid CoZn-ZIF-8 and physical mixture of Co-ZIF-8 and Zn-ZIF-8.

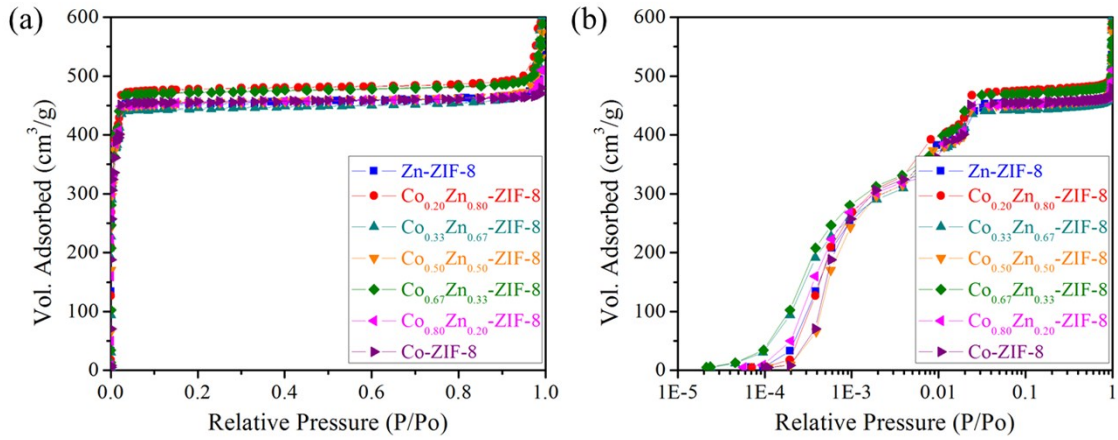


**Figure S10.** Nitrogen physisorption isotherm of CoZnZIF-8 with various Co/Zn content at 77 K (a) with the linear scale x-axis, and (b) with the log scale x-axis.

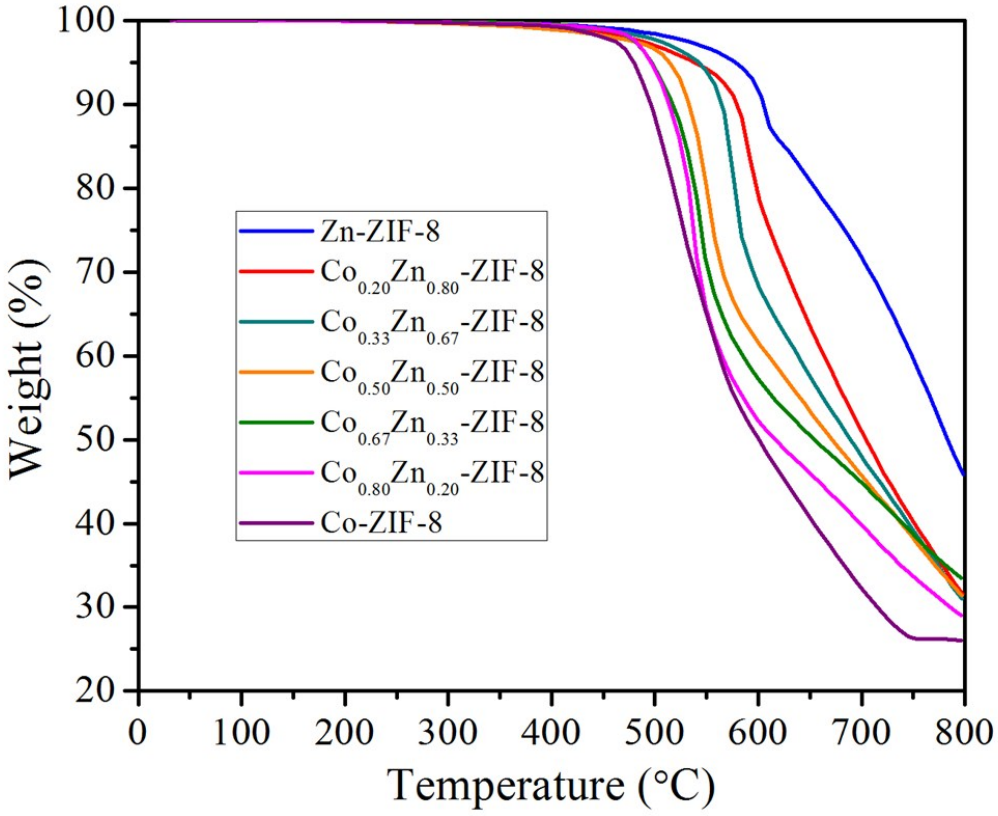


**Figure S11.** Thermogravimetric analysis on mixed metal CoZn-ZIF-8 with various ratios of Co to Zn.

**Table S2.** Comparison of micropore volume and BET surface area of mixed metal CoZn-ZIF-8

| | **Micropore Volume ($cm^3/g$)** | **Surface Area ($m^2/g$)*** |
|---|---|---|
| Zn-ZIF-8 | 0.688 | 1202.3 |
| Co0.20Zn0.80-ZIF-8 | 0.716 | 1295.2 |
| Co0.33Zn0.67-ZIF-8 | 0.667 | 1207.8 |
| Co0.50Zn0.50-ZIF-8 | 0.681 | 1232.6 |
| Co0.67Zn0.33-ZIF-8 | 0.711 | 1281.3 |
| Co0.80Zn0.20-ZIF-8 | 0.684 | 1231.1 |
| Co-ZIF-8 | 0.694 | 1235.0 |

*BET surface area

## 2. Mixed Ligand ZIF-7-8

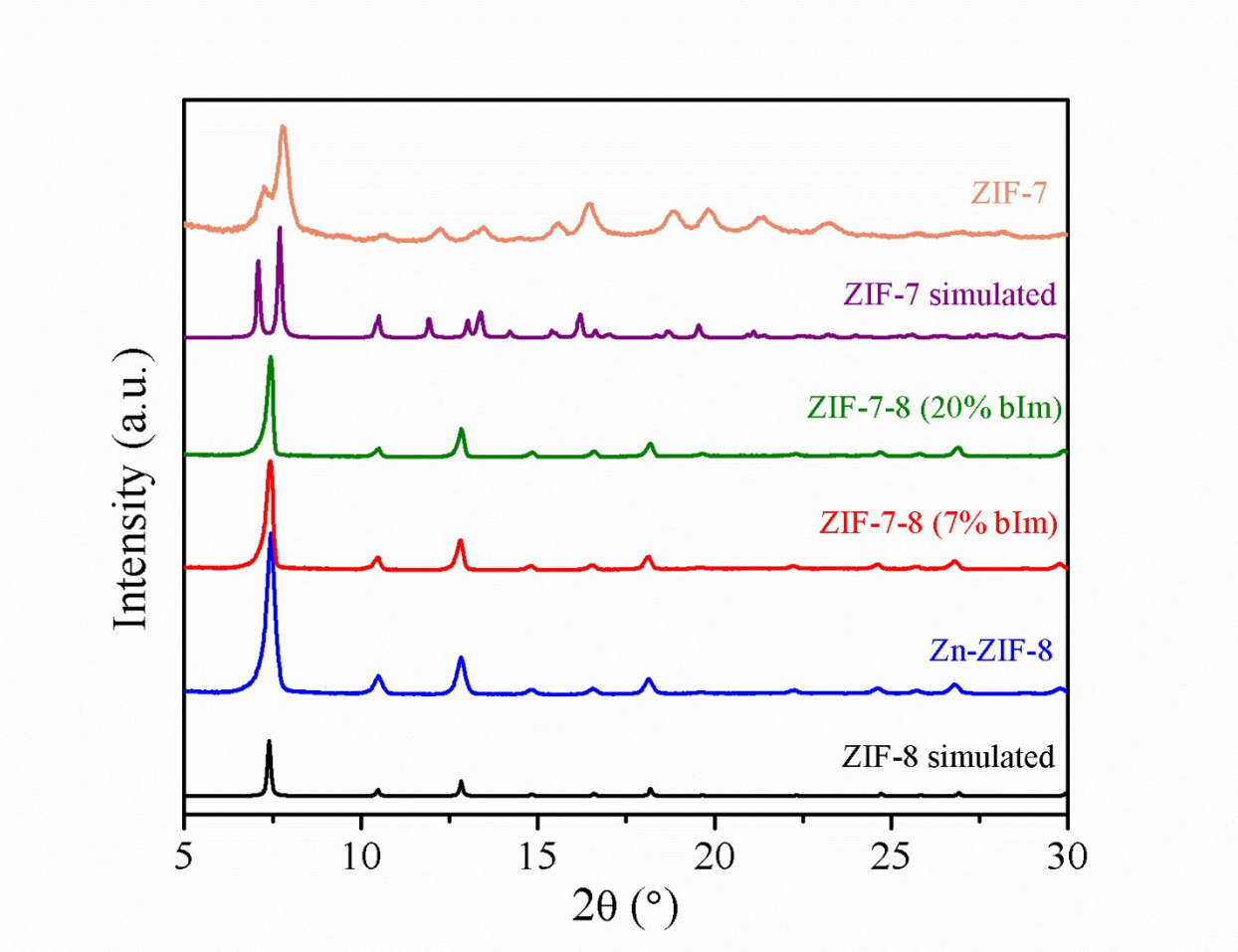


**Figure S12.** Powder x-ray diffraction (PXRD) pattern of ZIF-7-8 with various amount of benzimidazole incorporation**.**

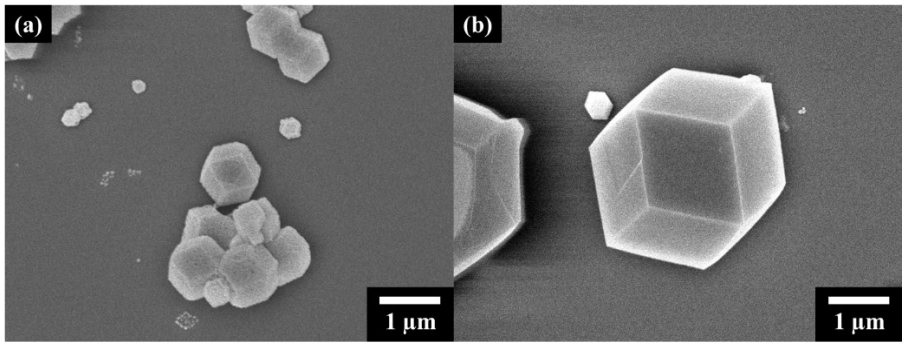


**Figure S13.** SEM images of ZIF-7-8 with (a) 7% bIm incorporation, (b) 20% bIm incorporation.

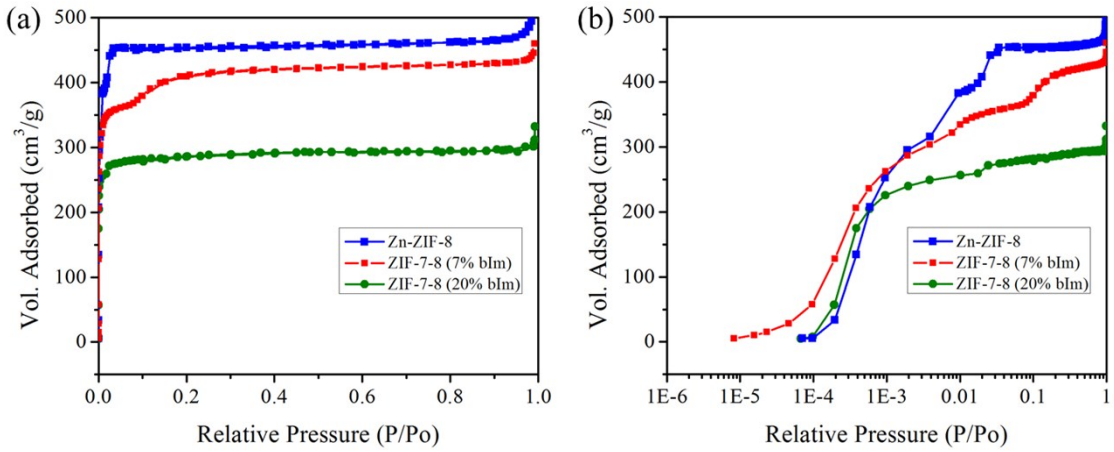


**Figure S14.** Nitrogen physisorption isotherm of ZIF-7-8 with various bIm content at 77 K (a) with linear scale x-axis, and (b) with log scale x-axis.

## 3. Mixed Metal and Ligand CoZn-ZIF-7-8

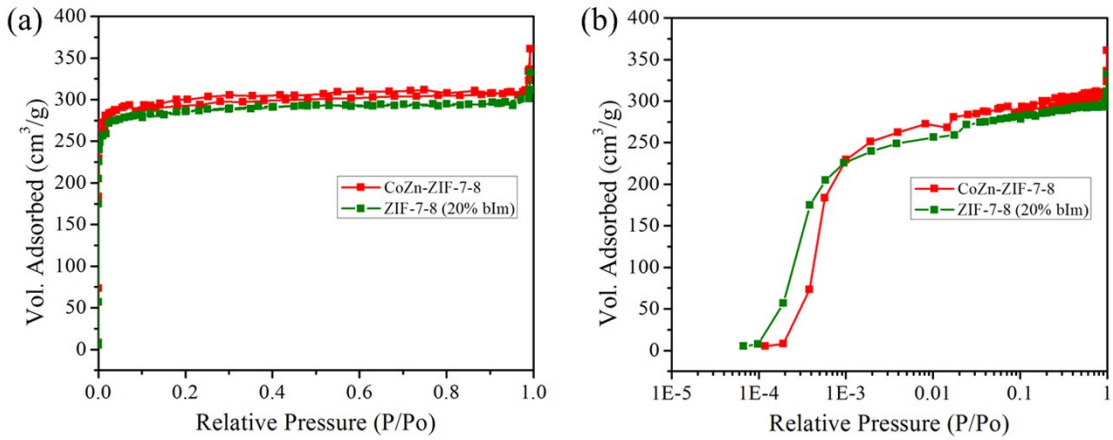


**Figure S15.** Comparison of nitrogen physisorption on mixed metal and ligand CoZn-ZIF-7-8 (Co to Zn ratio of 1 and 20% bIm) with ZIF-7-8 (20% bIm) (a) with linear scale x-axis, and (b) with log scale x-axis.

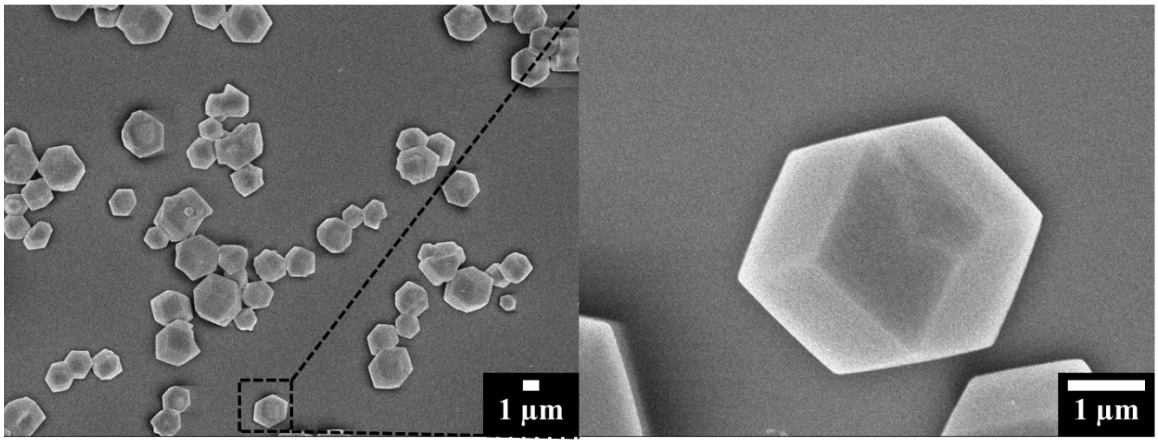


**Figure S16.** SEM image of mixed metal and ligand CoZn-ZIF-7-8.

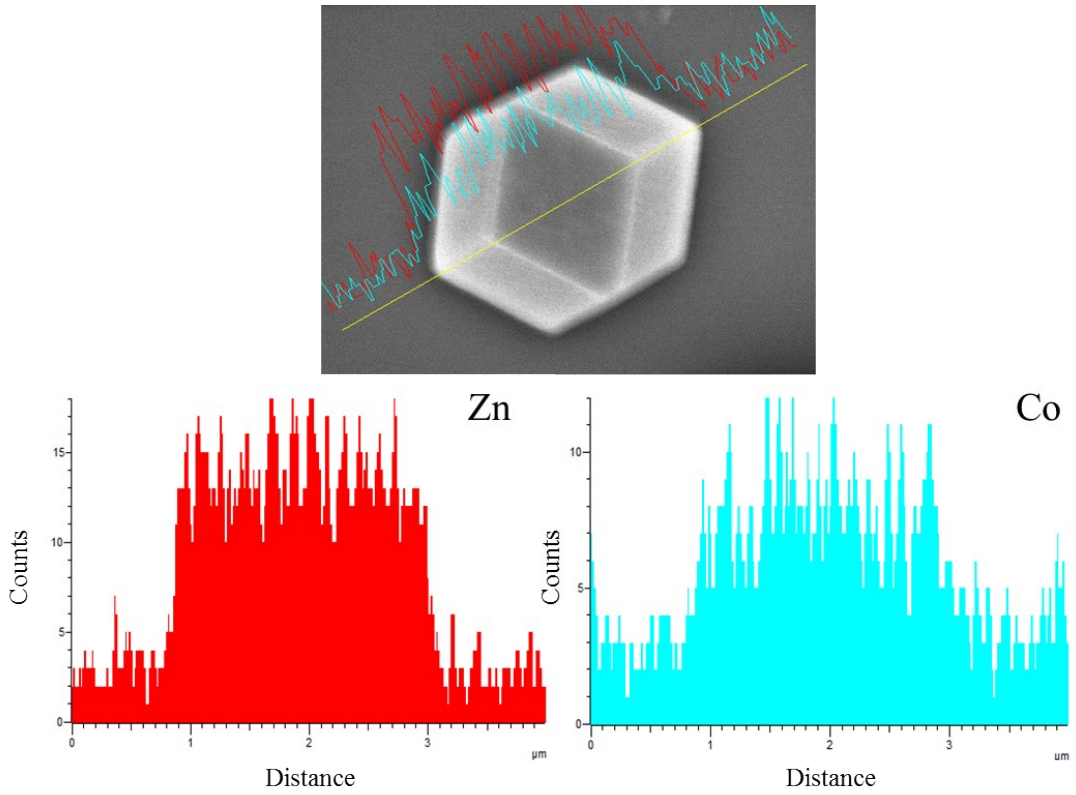


**Figure S17.** SEM-EDS line scanning of CoZn-ZIF-7-8 (Co to Zn ratio of 1 and 20% bIm).

## 4. CoZn-ZIF-8 Membrane

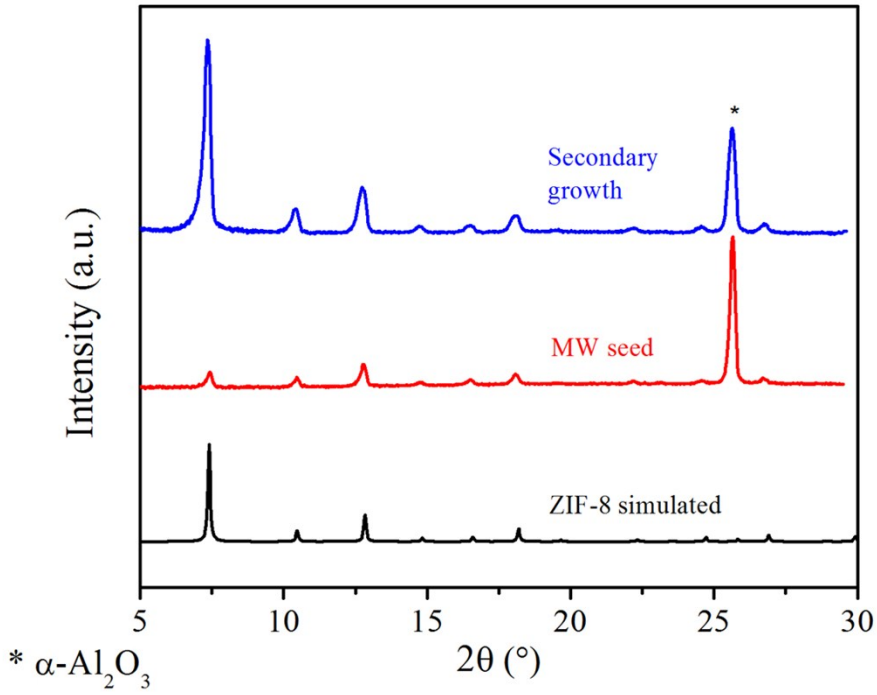


**Figure S18.** Powder x-ray diffraction (PXRD) pattern of $Co_{0.50}Zn_{0.50}$-ZIF-8 membrane with microwave seeding and after secondary growth.

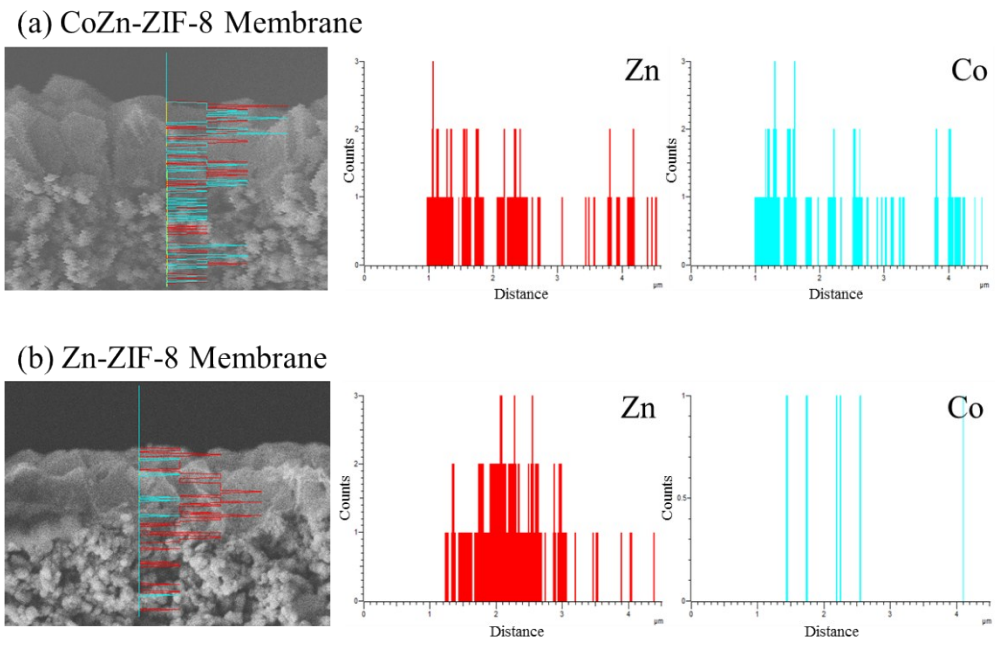


**Figure S19.** SEM-EDS line scanning of (a) $Co_{0.50}Zn_{0.50}$-ZIF-8 membrane, and (b) Zn-ZIF-8 membrane for element Zn and Co.