

## Electronic Supplementary Information

### A Green and Facile Approach to Obtain 100nm Zeolitic Imidazolate Framework-90 (ZIF-90) Particles via Leveraging Viscosity Effects

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## Chemical Section

**Chemicals:** N,N-dimethylformamide (DMF), methanol, ethanol, 2-propanol (IPA), and *tert*-butanol were purchased from Scharlan. Zinc nitrate and glycerol were obtained from SHOWA. Cetyltrimethylammonium bromide (CTAB), and polyvinylpyrrolidone (PVP, MW: 40,000) were purchased from Sigma-Aldrich. Imidazole-2-carboxaldehyde (ICA) was obtained from Alfa Aesar. All chemicals were used without further purification.

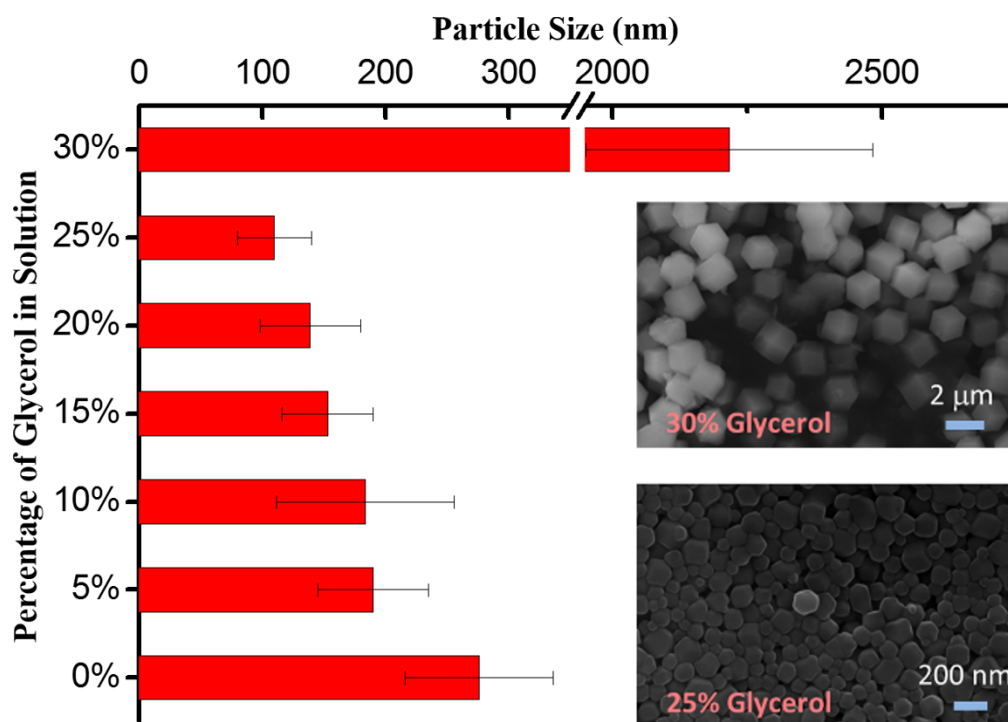
## Experimental Section

**NanoZIF-90 synthesized in water-alcohol-based system:** For a typical water/alcohol/PVP system, ZIF-90 was synthesized as follows: zinc nitrate (371.25 mg) was added into *tert*-butanol/H<sub>2</sub>O with ratio held on 1:1 (20 ml) as a triggered solvent (solution A). Then, this triggered solution was added to 20 ml mixed solution (solution B) of DI water and glycerol as a modifier as well as also containing imidazole-2-carboxaldehyde (ICA, 480.0 mg) and PVP (50.0 mg). The molar ratio of Zn<sup>2+</sup>: ICA and the concentration of PVP in this case were held at 1:4 and 0.2 wt%, respectively. Furthermore, the ratio (v/v) of DI water /glycerol for the solution B could be adjusted as from 9:1(5% (v/v) glycerol in the final mixed solution) to 1:1(25% (v/v) glycerol in the final mixed solution). After mixing, the resulting powder was stirred for few minutes. All reactions were done at room temperature. Finally, the as-obtained products were collected by centrifugation (14,000 g), washed with excess methanol, and vacuum dried at 50 °C.

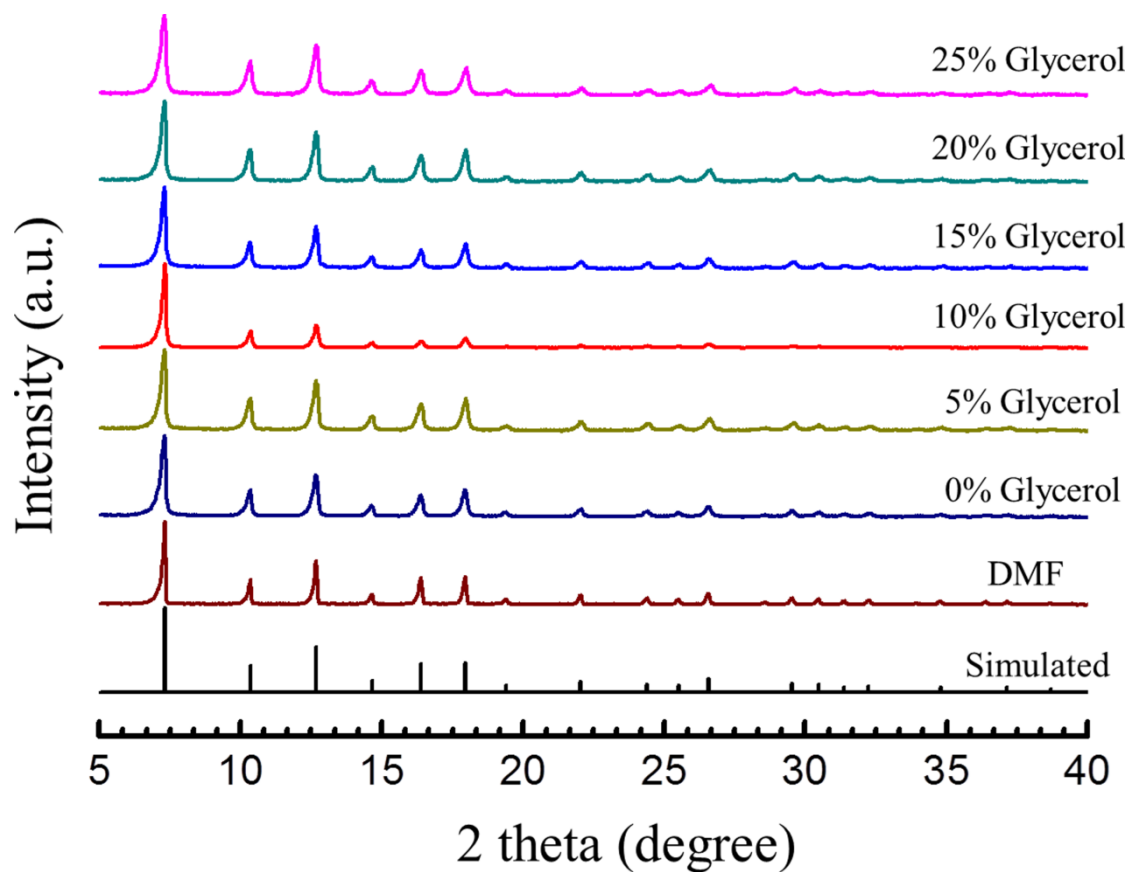
**CTAB capping on nanoZIF-90 for cytotoxicity assay:** The CTAB-capped nanoZIF-90 particles were prepared by the method described in the literatures.<sup>1,2</sup> During the nanoZIF-90 particle synthesis as mentioned in the section of NanoZIF-90 synthesized in water-alcohol-based system, 4.0 mg of CTAB was added to the triggered solvent (solution A) and then solution A mixed with solution B under ambient condition. The resulting powder of as-synthesized nanoZIF-90 particles must be washed with DI water overnight to remove any remaining CTAB. Then, 2 mg ZIF-90 was added to 1 ml DI water and placed in sonicator 3 min to obtain a homogeneous solution for the next Cytotoxicity assay. All containers, tips, and nanoZIF-90 used for cytotoxicity assay were used with autoclave.

**AlamarBlue assay:** HEK-293 cells were obtained from American Type Culture Collection and maintained in Dulbecco's modified Eagle's medium (Gibco, CA, USA) supplemented with heat-inactivated 5% fetal bovine serum, 100 U/ml penicillin and 100 mg/ml streptomycin at 37°C with 5% CO<sub>2</sub>. 3X10<sup>4</sup> HEK-293 cells were cultured in 48-well plate and treated with different amounts of nanoZIF-90 or control. After forty-eight hours, cell proliferation was determined by AlamarBlue assay (Invitrogen, CA, USA) according to the manufacturer's instructions. The fluorescence values were measured with excitation wavelength at 530-560 nm and emission wavelength at 590 nm. All measured values were detected by Synergy HT (BioTek, VT, USA).

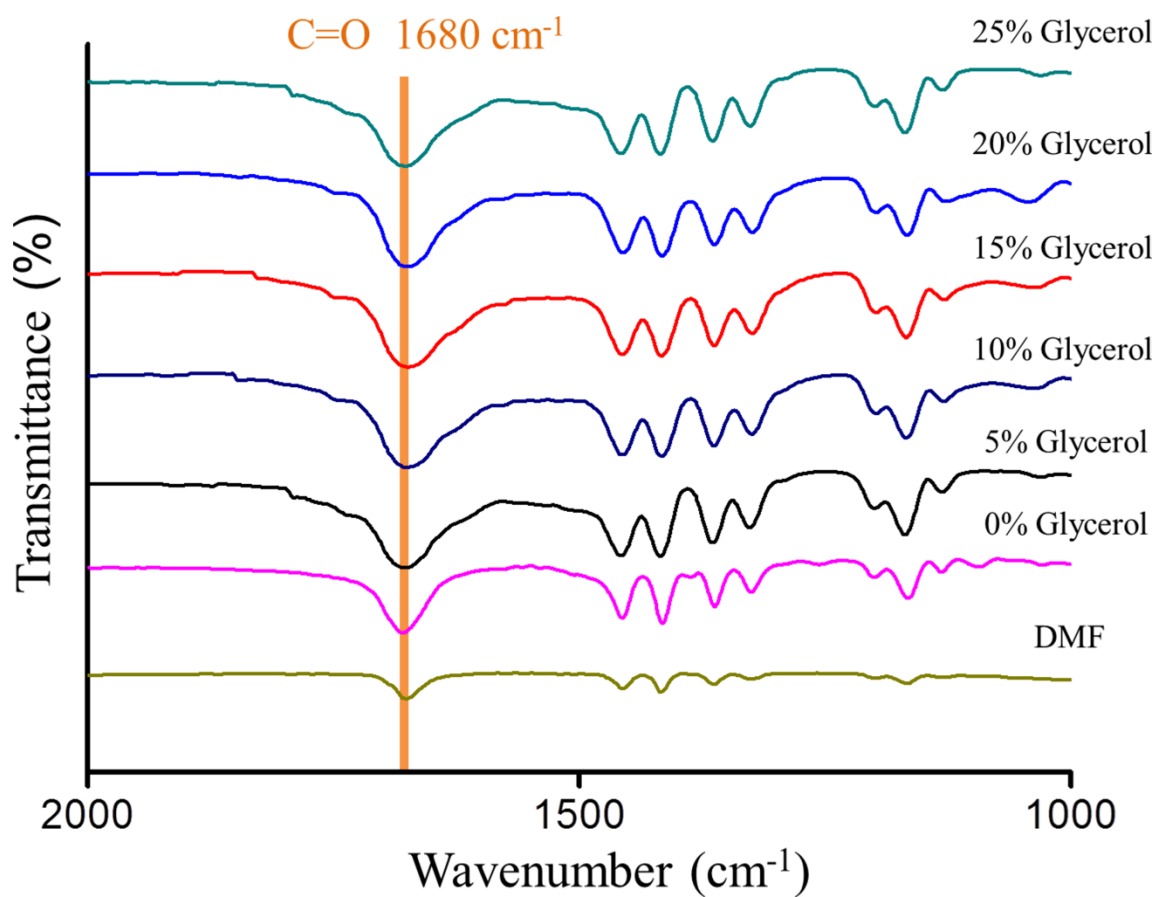
**Characterization:** Powder XRD patterns were collected by PANalytical X'Pert PRO. N<sub>2</sub> adsorption–desorption isotherms were measured at 77 K on a Micromeritics ASAP 2020 analyzer. The samples were degassed at 95 °C for 24 h before the measurements. Specific surface areas were calculated using the Brunauer–Emmett–Teller (BET) method in the relative pressure range  $P/P_0 = 0.05–0.30$ . Pore volumes were obtained from the volumes of N<sub>2</sub> adsorbed at  $P/P_0 = 0.95$  or in the vicinity. Fourier transform infrared (FTIR) spectra of the samples were recorded at room temperature on a JASCO FT/IR-4100. Each sample was scanned 20 times at 4 cm<sup>-1</sup> resolution over the 4000–400 cm<sup>-1</sup> range. Solid-state <sup>13</sup>C CP/MAS NMR spectra were recorded by using a contact time of 3 ms on a Varian Infinityplus-500 NMR spectrometer, equipped with a 5.0 mm Chemagnetics probe. The Larmor frequency for the <sup>13</sup>C nucleus is 125.7 MHz. The <sup>13</sup>C chemical shift was externally referenced to tetramethylsilane (TMS) at 0.0 ppm. Field-emission scanning electron microscope (FE-SEM) pictures were taken by JEOL JSM-7000, and the acceleration voltage was 15kV. The particle size was measured by counting all particles in the SEM image. We understand that SEM only looks at discrete portion (not the whole part) of the sample. In order to avoid such erroneous judgment, we took at least five portions for one sample. Thermal gravimetric analysis (TGA) measurements were performed on METTLER SDTA851. Then, ca. 2 mg samples were filled into an alumina crucible and heated in a continuous-flow of nitrogen gas with a ramp rate of 10 °C/min from 25 up to 800 °C.



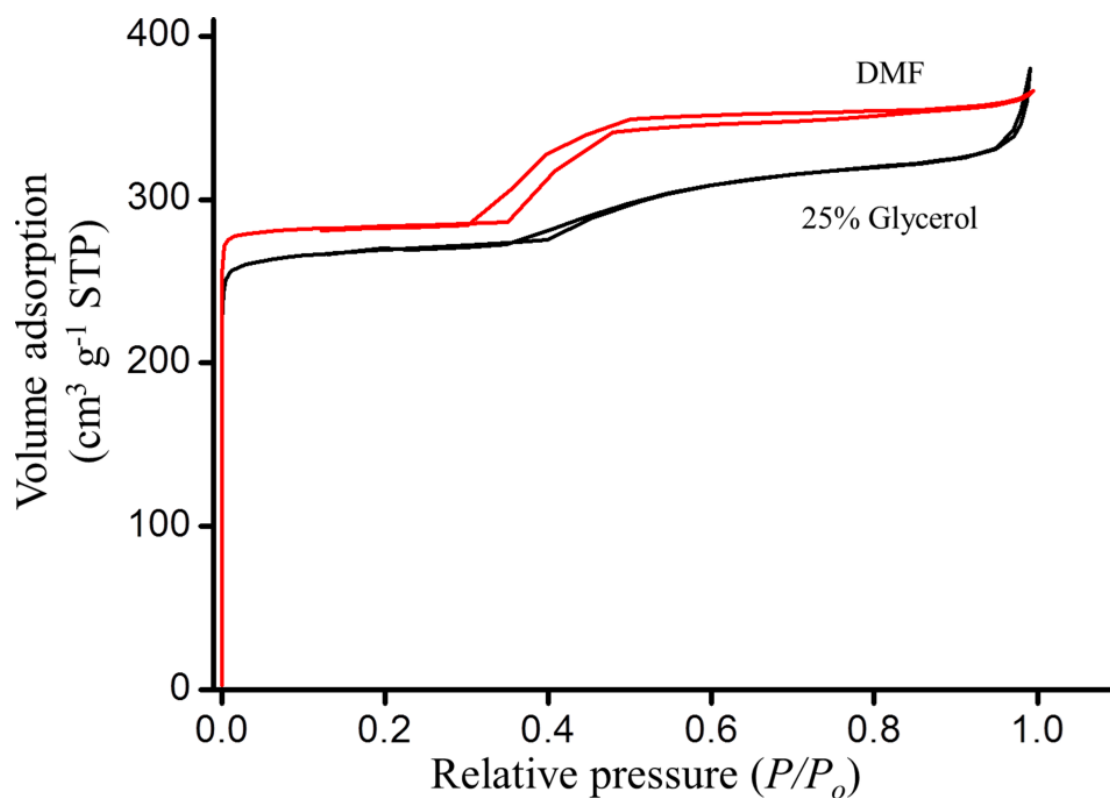
**Fig. S1. Viscosity effects for controlling particles size.** Particle size of ZIF-90 obtained by different percentages of glycerol from in 0%~30% in water-alcohol-based system. The SEM images of ZIF-90 particles given by 25% and 30% glycerol in the system.



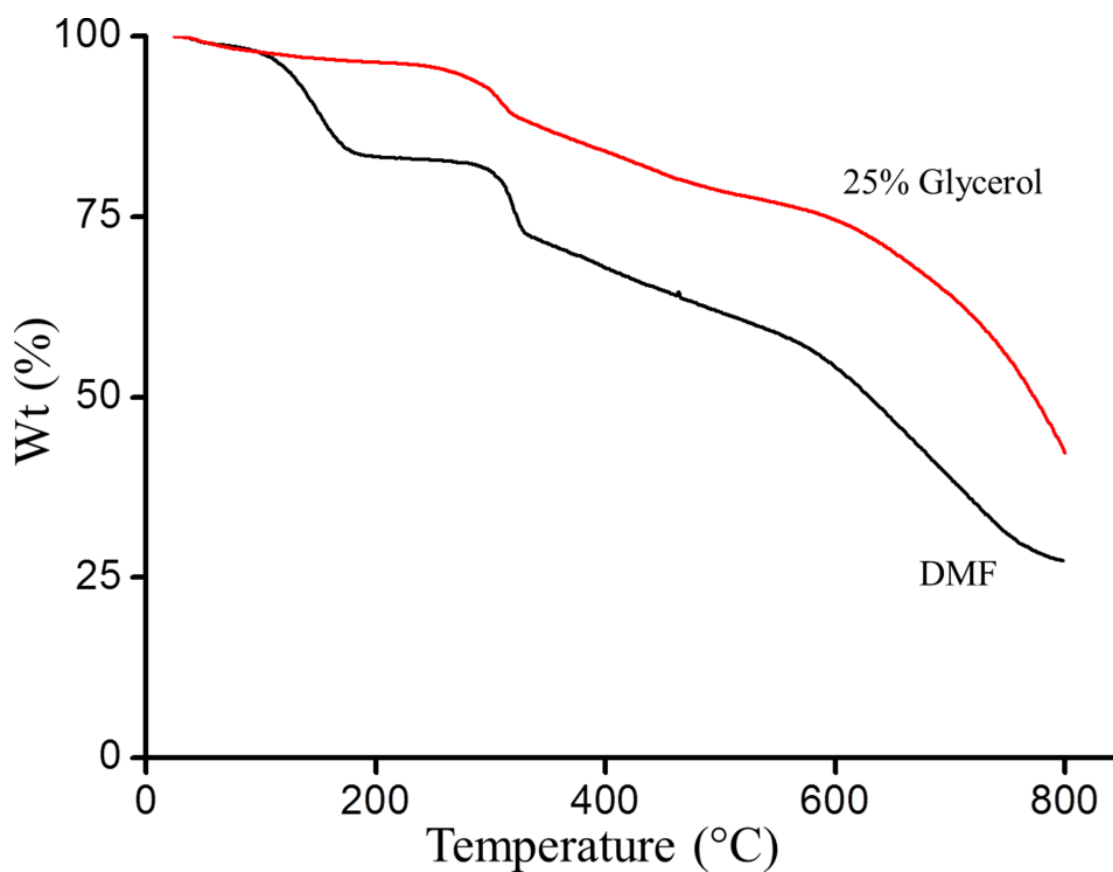
**Fig. S2. XRD patterns.** The ZIF-90 materials synthesized by various percentage of glycerol in water-alcohol-based system and DMF.



**Fig. S3. FTIR spectra.** The ZIF-90 materials prepared by different percentage of glycerol in water-alcohol-based system and DMF

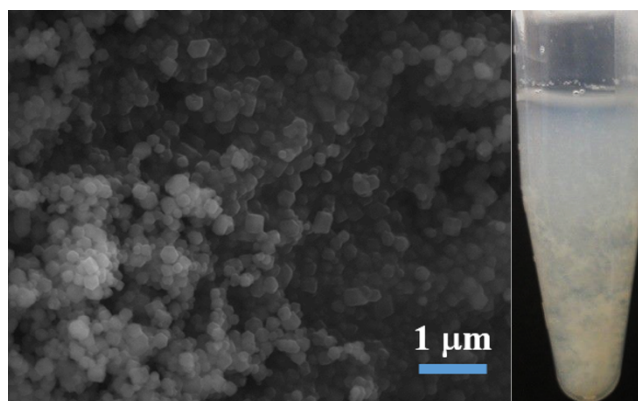


**Fig. S4. N<sub>2</sub> adsorption-desorption measurements.** BET analysis of the ZIF-90 materials prepared in water-alcohol-based system in presence of 25% glycerol (black line) and DMF (red line).



**Fig. S5. The measurements of thermal properties.** TGA curves of ZIF-90 materials prepared in DMF (black line) and water-alcohol-based system in presence of 25% glycerol (red line).





**Fig. S6. SEM.** The ZIF-90 nanoparticles without CTAB capped in a bad distribution. Inset: particles with not good dispersity in solution and aggregation in a few minutes after synthesis.

## References

1. Y. Pan, D. Heryadi, F. Zhou, L. Zhao, G. Lestari, H. Su and Z. Lai, *CrystEngComm*, 2011, 13, 6937-6940.
2. J. Zhuang, C.-H. Kuo, L.-Y. Chou, D.-Y. Liu, E. Weerapana and C.-K. Tsung, *ACS Nano*, 2014, 8, 2812-2819.