Supporting Information:

Novel electrorheological properties of a metal-organic framework $Cu_3(BTC)_2$

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Experimental Section

1. $Cu_3(BTC)_2$ synthesis and characterization

$Cu_3(BTC)_2$ is prepared based on the ethanol reflux method proposed by Hartmann et al. [1] . In a typical synthesis, 175 g copper (II) nitrate hydrate (Sigma-Aldrich, 98%) and 84 g 1,3,5-benzenetricarboxylic acid (H_3BTC, Sigma-Aldrich, 95%) were dissolved in 500 ml of ethanol. The substrate mixture was heated under reflux for 24 h with stirring at 300 rpm in a 1 L-capacity glass reactor. The product was then collected by filtration, washed once with de-ionized water and then repeated with ethanol. The powder product was dried at 100 ^oC for 5 h in a vacuum oven and further activated at 180 ^oC for 12 h under vacuum (5 x 10^{-3} torr) for characterization.

The crystallinity of the $Cu_3(BTC)_2$ was measured by powder X-ray diffraction (PXRD) using CuKα (λ = 1.54 Å) radiation (Rigaku-miniflex). Nitrogen adsorption-desorption isotherms were measured using a BELsorp-mini (BEL, Japan) at 77 K. The specific surface area of the $Cu_3(BTC)_2$ sample was calculated by the Brunauer-Emmett-Teller (BET) method. Scanning electron microscopy (SEM) image was taken using a Hitachi S-4300 electron microscope. The thermal stability of the crystals was tested using thermo-gravimetric analysis (TGA, SCINO thermal gravimeter S-1000): 10 mg of the sample was heated to 10 ^oC/min to 500 ^oC under a N_2 flow (30 ml/min).

[1] M. Hartmann, S. Kunz, D. Himsl and O. Tangermann, *Langmuir* 2008, **24**, 8634-8642.

2. Water vapor sorption measurement

Water vapor sorption isotherm of the $Cu_3(BTC)_2$ sample prepared was measured over a BELsorp-Max (BEL, Japan) at 25 ^oC (P_0 = 3.169 kPa). Water vapor was created by soaking procedure, which vaporizes water under ultra-high vacuum at 40 ^oC and repeatedly freezing the water using liquid nitrogen and subsequently melting the water and evacuating bubbles of other dissolved materials. The sample was pre-treated by the same activation procedure as for the N_2 adsorption before taking sorption measurements.

3. Preparation of ER fluid and ER characterization

A 15 vol% ER fluid was prepared by mixing the $Cu_3(BTC)_2$ dry powders in silicone oil (Shinetsu, 50 cSt) with mechanical shaking and sonication. Dielectric spectra of the ER fluid were detected by a LCR meter (Agilent HP 4284A) in the frequency range 20-10^6 Hz. Then a proper amount of the as-prepared ER fluid was injected into the cylinder cell of a rotational rheometer (MCR300, Physica) equipped a high power supplier (HCN 7E-12 500, Fug) for generating tunable electric field to the sample when it was measured under rotation test. Flow curves with controlled shear rate (CSS) were measured in the range of 0.1-1000 s^{-1} and analyzed by typical flow equations of state.

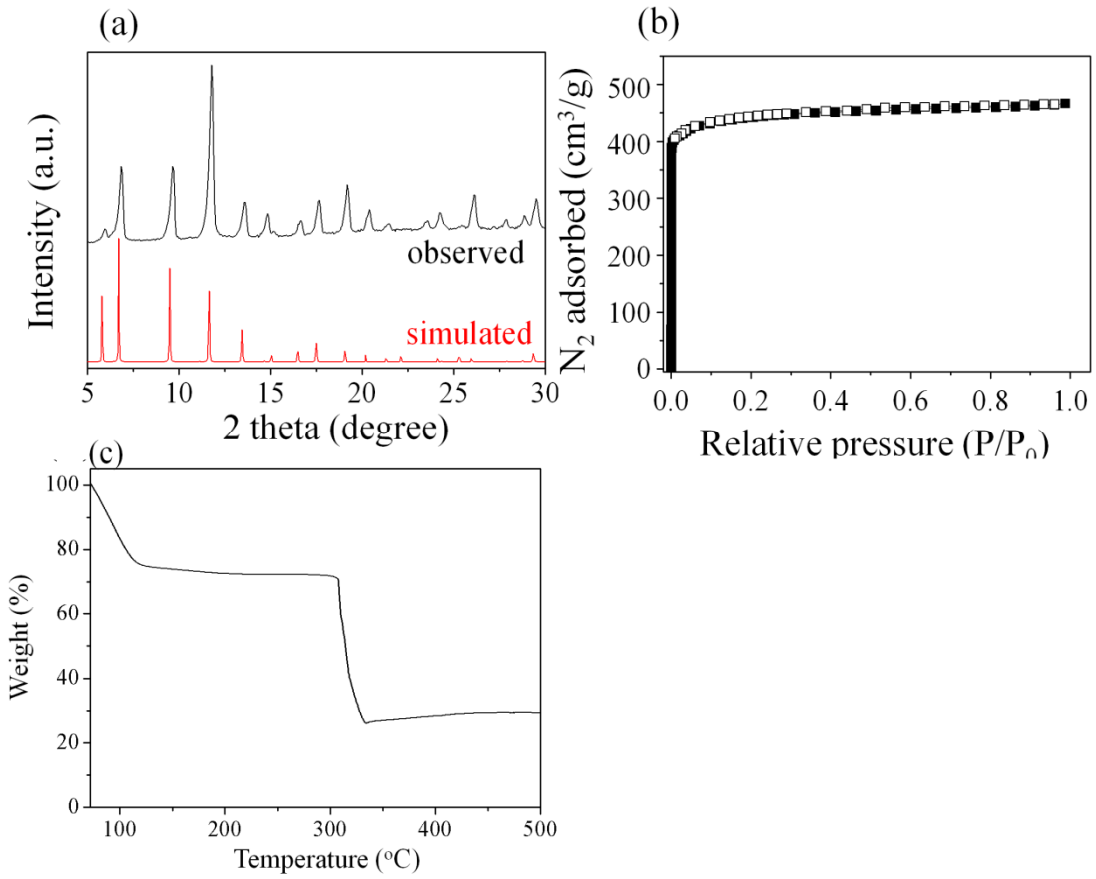

Fig. S1 (a) XRD, (b) N_2 adsorption-desorption isotherm at -196 ^{o}C, and (c) TGA of $Cu_3(BTC)_2$ synthesized by ethanol reflux method at ambient pressure for 24 h.

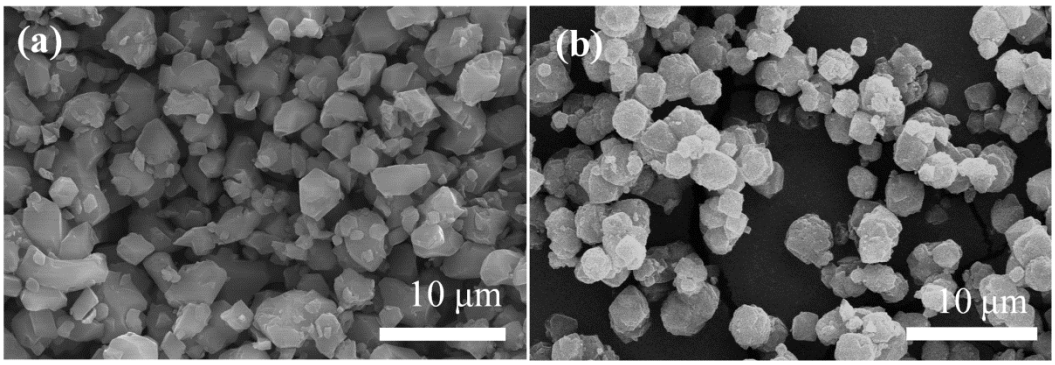

Fig. S2 SEM images of $Cu_2(BTC)_3$ (a) and zeolite 13X (b).

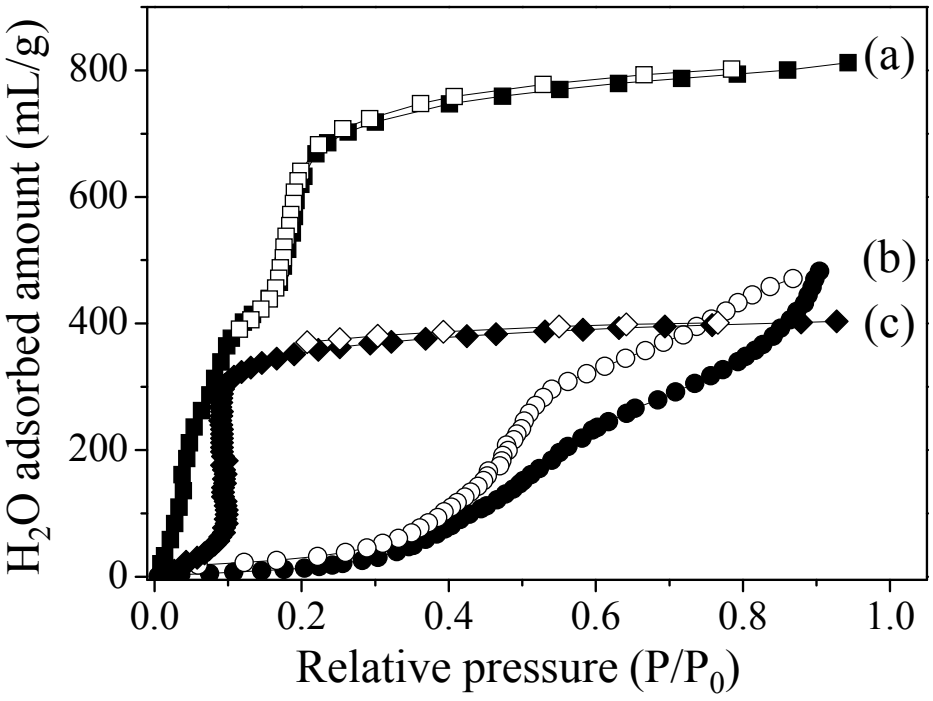

Fig. S3 Water vapour adsorption isotherms at 25 ^{o}C for (a, square) $Cu_3(BTC)_2$, (b, circle) zeolite 13X, and (c, diamond) activated carbon.

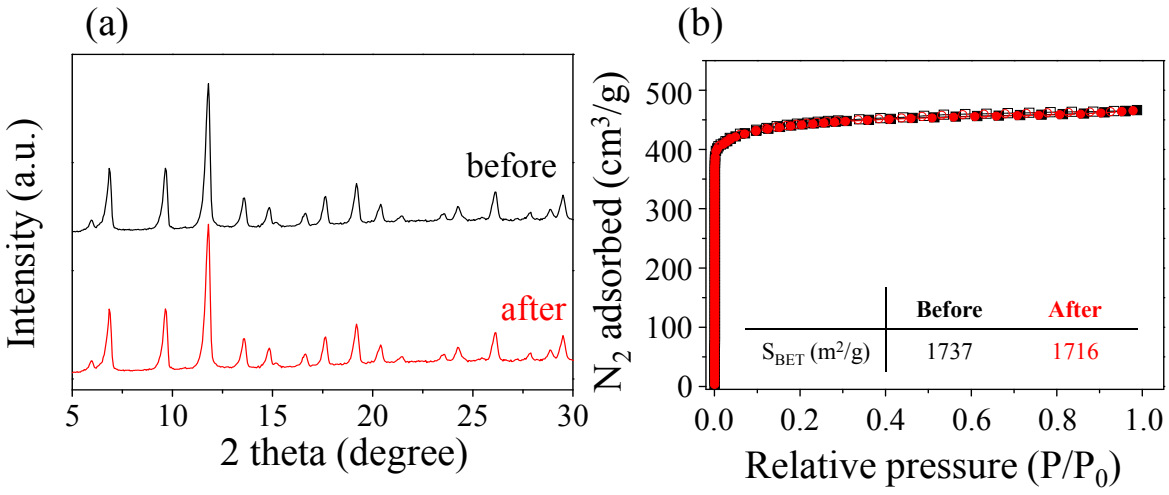

Fig. S4 (a) XRD patterns and (b) the (at -196 ^{o}C) of $Cu_3(BTC)_2$ before and after water adsorption.

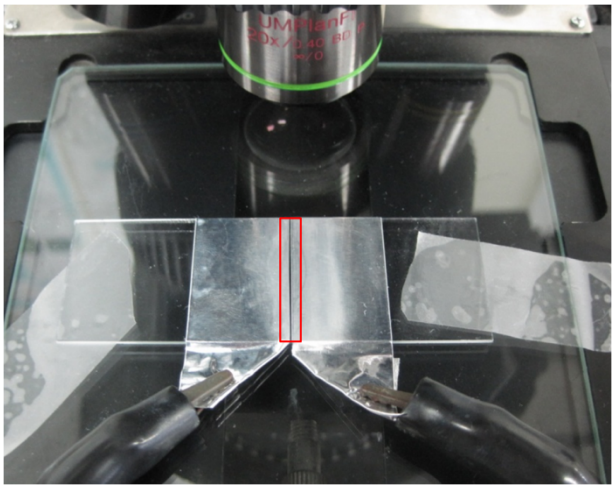

Fig. S5 Digital image of the aluminum electrodes, between the narrow gap of which ER fluid sample was loaded and observed though the optical microscope.

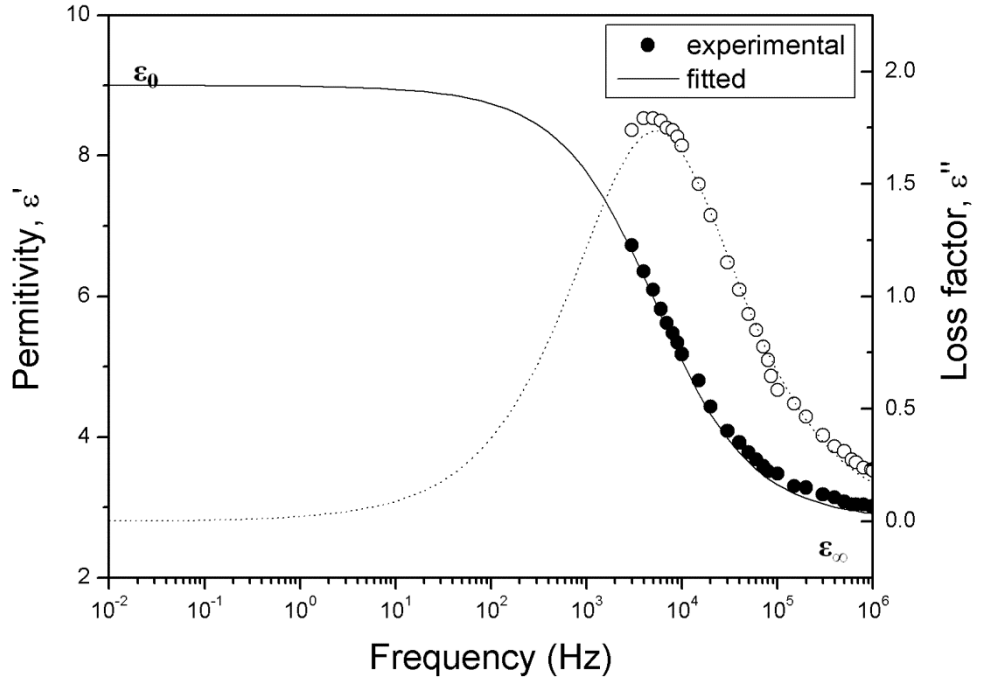

Fig. S6 Dielectric spectra (permittivity: closed; loss factor: open) of the 15 vol% zeolite 13X-based ER fluid. $\Delta\varepsilon=\varepsilon-\varepsilon_\infty=6.2$.

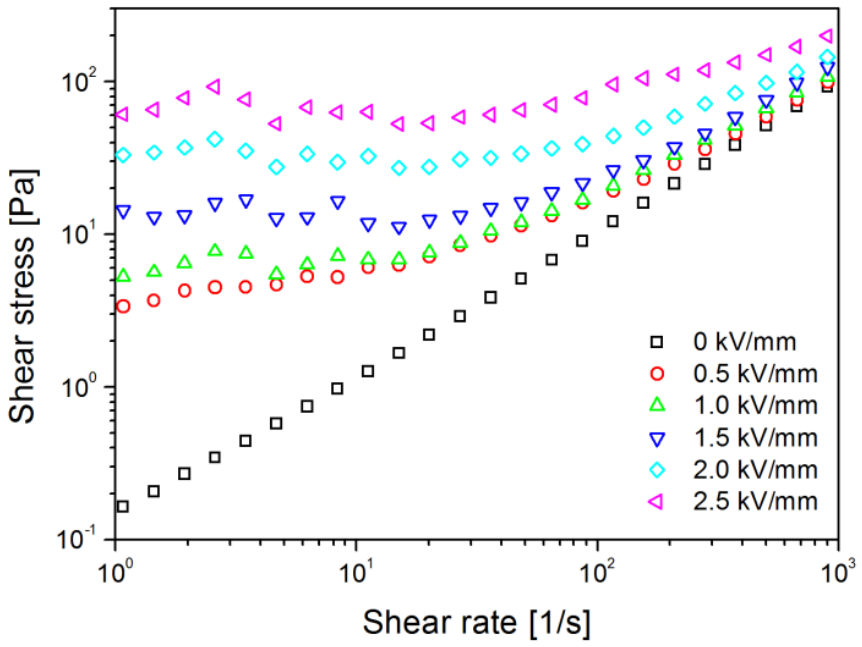

Fig. S7 Shear stress vs. shear rate curves of zeolite 13X ER fluid under various electric field strengths.

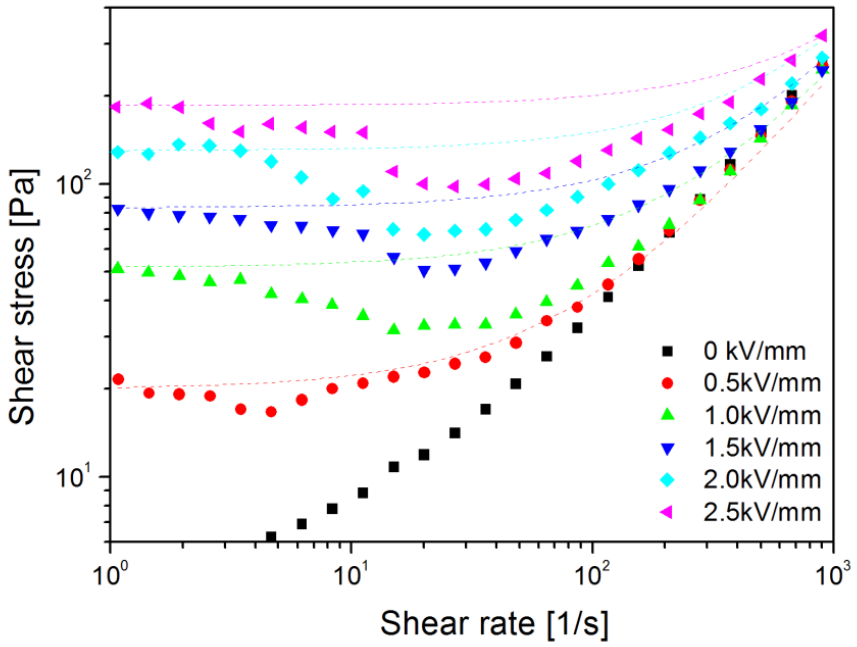

Fig. S8 Shear stress vs. shear rate curves of $Cu_3(BTC)_2$ ER fluid under various electric field strengths. The dash lines were fitted from the Bingham equation.