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Supporting Information

Title: Gas-Solid two-phase Flow (GSF) Mechanochemical Synthesis Dual-Metal-Organic Frameworks and Electrochemical Properties Research

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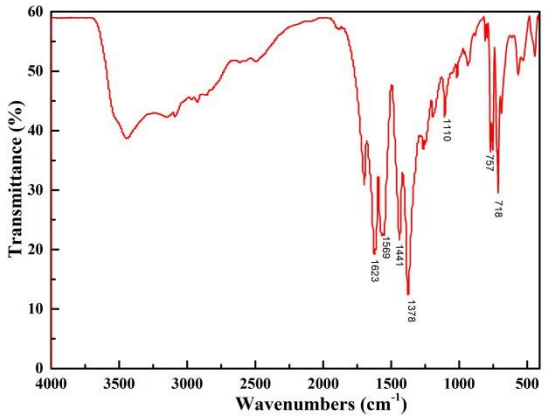

Fig. S1 Fourier transform infrared spectroscopy (FT-IR) spectra of $CoMn_2(BTC)_2$

It can be seen from **Fig. S1** that the FT-IR spectra of $CoMn_2(BTC)_2$ synthesized by GSF was identical with the previously reported.[1] The asymmetric stretching vibrations and symmetric stretching vibrations of −COO−appeared in the regions 1623−1569 cm^{-1} and 1441−1378 cm^{-1}, respectively. The absorption at 757cm^{-1}, 1110 cm^{-1} were C-O-Mn and C-O-Co stretching vibration peaks, which suggested that the metal ions have been coordinated with the BTC successfully.

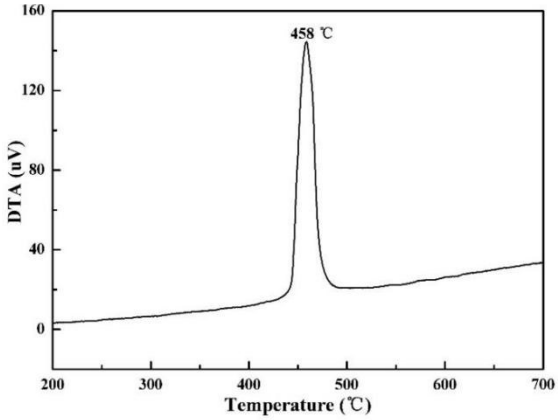

Fig. S2 DTA of $CoMn_2(BTC)_2$

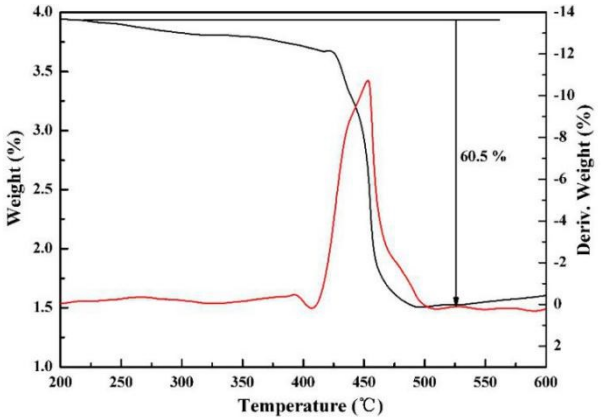

Fig. S3 TG/DTG of $CoMn_2(BTC)_2$

In order to further verify the synthesized $CoMn_2(BTC)_2$, DTA analysis was shown in **Fig. S2-S3**. According to the DTA, TG/DTG curves, the initial decomposition peak was about at 458℃ and $CoMn_2(BTC)_2$ showed good thermal stability. The above information was completely consistent with the literature reports.[1]

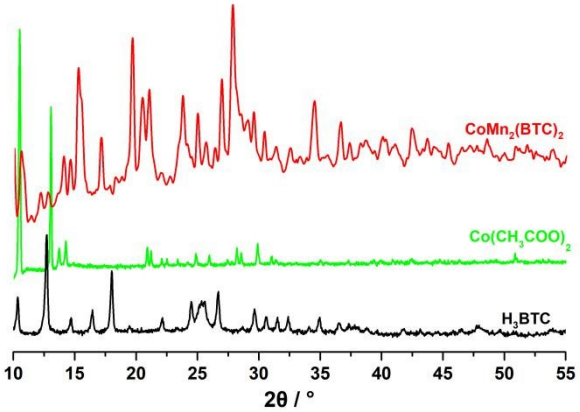

Fig. S4 XRD comparison of H_3BTC, $Co(CH_3COO)_2$, $CoMn_2(BTC)_2$

As shown in **Fig S4**, we also added the XRD comparison of H_3BTC, $Co(CH_3COO)_2$, $CoMn_2(BTC)_2$. It further explained that the raw materials (H_3BTC, $Co(CH_3COO)_2$) reacted in the GSF and generated $CoMn_2(BTC)_2$.

Fig. S5 GSF reaction equipment with key parts highlighted.

The reaction process flow chart of GSF chemical synthesis was shown in **Fig S5.** Reactant particles were transferred into the impacting chamber through the feed port, firstly. Afterward, the particles were accelerated to high velocities (300 m/s) by compressed air (1.5 MPa).

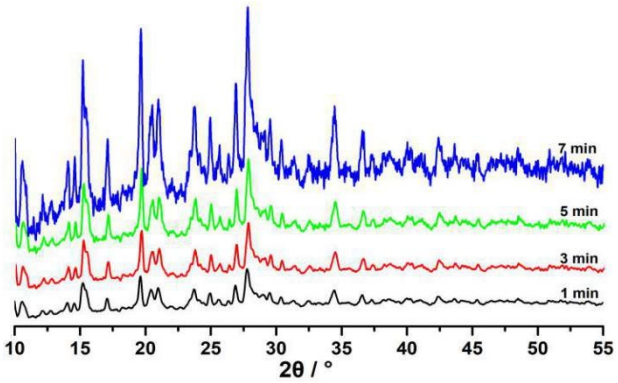

Fig. S6 XRD of the product collected at different times

The XRD of $CoMn_2(BTC)_2$ at different times was shown in **Fig S6**. The characteristic diffraction peaks of the raw material completely disappeared after collision reaction 10 min. Meanwhile, new diffraction peaks assigned to $CoMn_2(BTC)_2$ appeared (**Fig S5**), which basically consistent with the characteristic diffraction peak reported in the related literature.[1]

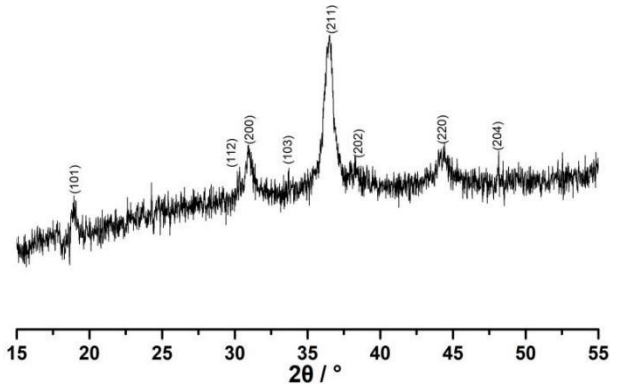

Fig. S7 XRD of the product collected after the TGA

As shown in **Fig S7**, The XRD results showed that the products after TGA still existed mainly in the form of $CoMn_2O_4$.

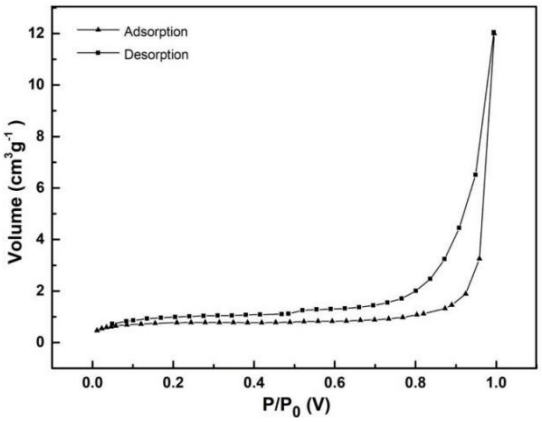

Fig. S8 N_2 adsorption/desorption isotherms of $CoMn_2(BTC)_2$

As shown in **Fig S8**, Nitrogen adsorption/desorption isotherms were conducted at 77 K to study the textural properties of the $CoMn_2(BTC)_2$ synthesized by GSF. The BET surfaces areas obtained from the nitrogen adsorption-desorption isotherms were 2.45 m²/g.

References

(S1) Hu, X. S.; Li, C.; Lou, X. B.; Yan, X. J,; Ning, Y. Q.; Chen, Q.; Hu, B. W. Controlled synthesis of $Co_xMn_{3-x}O_4$ nanoparticles with a tunable composition and size for high performance lithium-ion batteries. *RSC Advances*, **2016**, *6*(59), 54270-54276.