Electronic Supplementary Material (ESI) for New Journal of Chemistry.


# MXene-Supported Copper-Molybdenum Sulfide Nanostructures as Catalysts for Hydrogen Evolution

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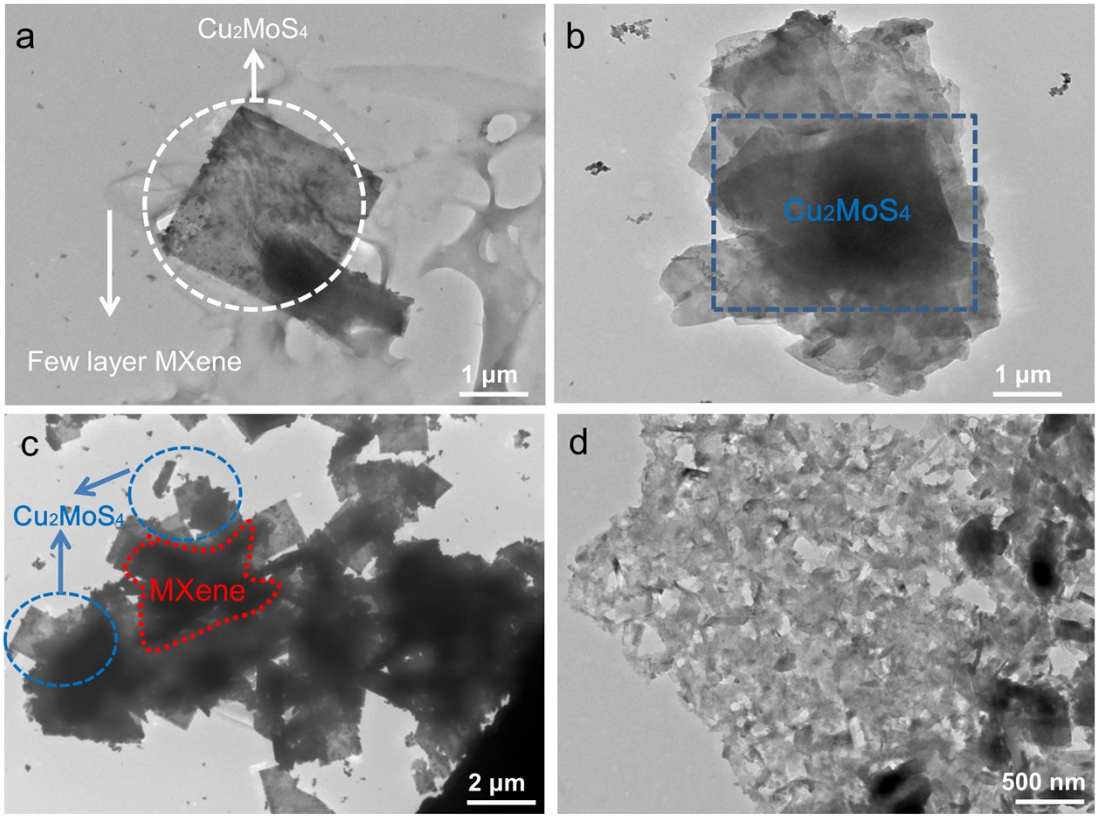


**Fig S1.** TEM of (a) $Cu_2MoS_4/Ti_3C_2T_x$-10%, (b) $Cu_2MoS_4/Ti_3C_2T_x$-50%, (c) $Cu_2MoS_4/Ti_3C_2T_x$-30% and (d) MXene ($Ti_3C_2T_x$)

The results showed that the morphology of MXene in Fig S1 (a) and Fig S1 (b) gradually matched with that of pure MXene (Fig S1 (d)) in TEM as the concentration of MXene increased. In Fig S1 (c), the TEM plot of $Cu_2MoS_4/Ti_3C_2T_x$-30% in the dense state does not differ from the SEM plot. It can also be demonstrated that the material has been synthesised. The stacking up of multiple layers has resulted in a severe loss of transparency of the MXene complex with copper molybdenum sulphide, resulting in a pitch black colour, but it is still possible to see the copper molybdenum sulphide coating the surface.the morphology did not change roughly with the stability test at 20h.

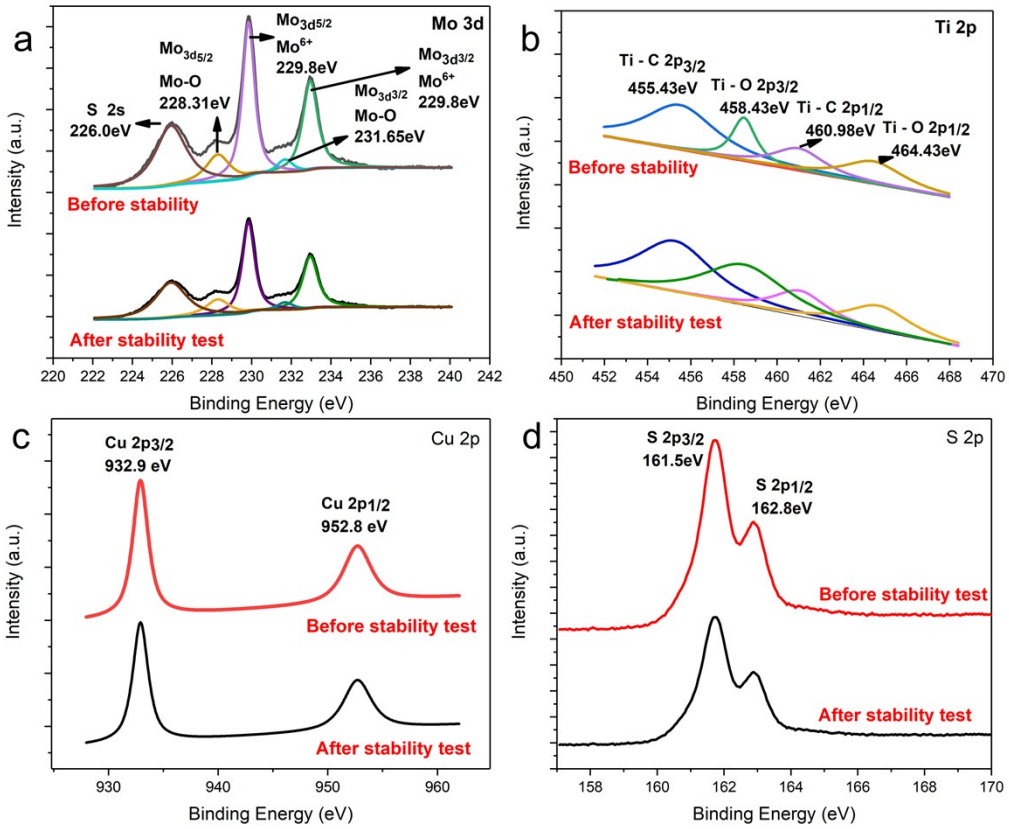


**Fig S2.** XPS spectra of (a) Mo 3d, (b) Ti 2p, (c) Cu 2p and (d) S 2p before and after the stability test

There are no significant changes observed in the Chemical state. As can be seen from Fig S2, the valence states of Cu, Mo, S and Ti do not show a relatively significant shift in peak position after stability test. These results indicate that the $Cu_2MoS_4/Ti_3C_2T_x$-30% is stable.

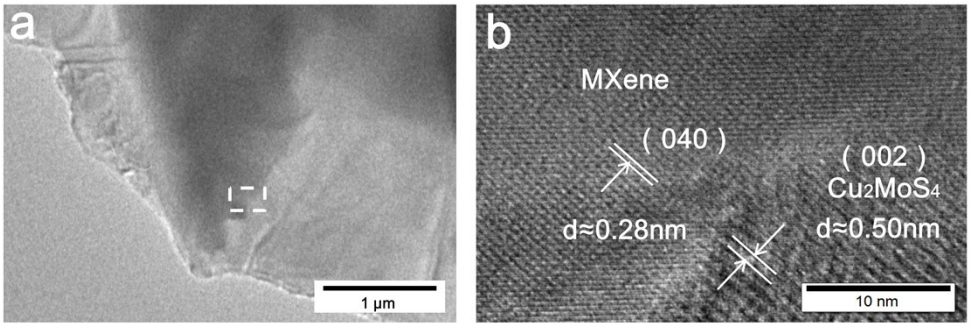


Fig.S3 HRTEM image of $Cu_2MoS_4/Ti_3C_2Tx$-30%

Fig.S3 shows the HR-TEM images of $Cu_2MoS_4$ and $Cu_2MoS_4/Ti_3C_2Tx$-30% samples. HRTEM images of $Cu_2MoS_4$ in Fig.R1b indicate the lattice spacing of MXene was about 0.28nm correspond to (040)[5] and $Cu_2MoS_4$ was about 0.50nm correspond to (002)[6]. In this case MXene can be seen as a distinct dendritic structure, while the dendrites of $Cu_2MoS_4$ are irregular and inhomogeneous in shape. It can therefore be concluded that the $Cu_2MoS_4$ grown on MXene, where MXene has some influence on the crystal structure of its edges[7].

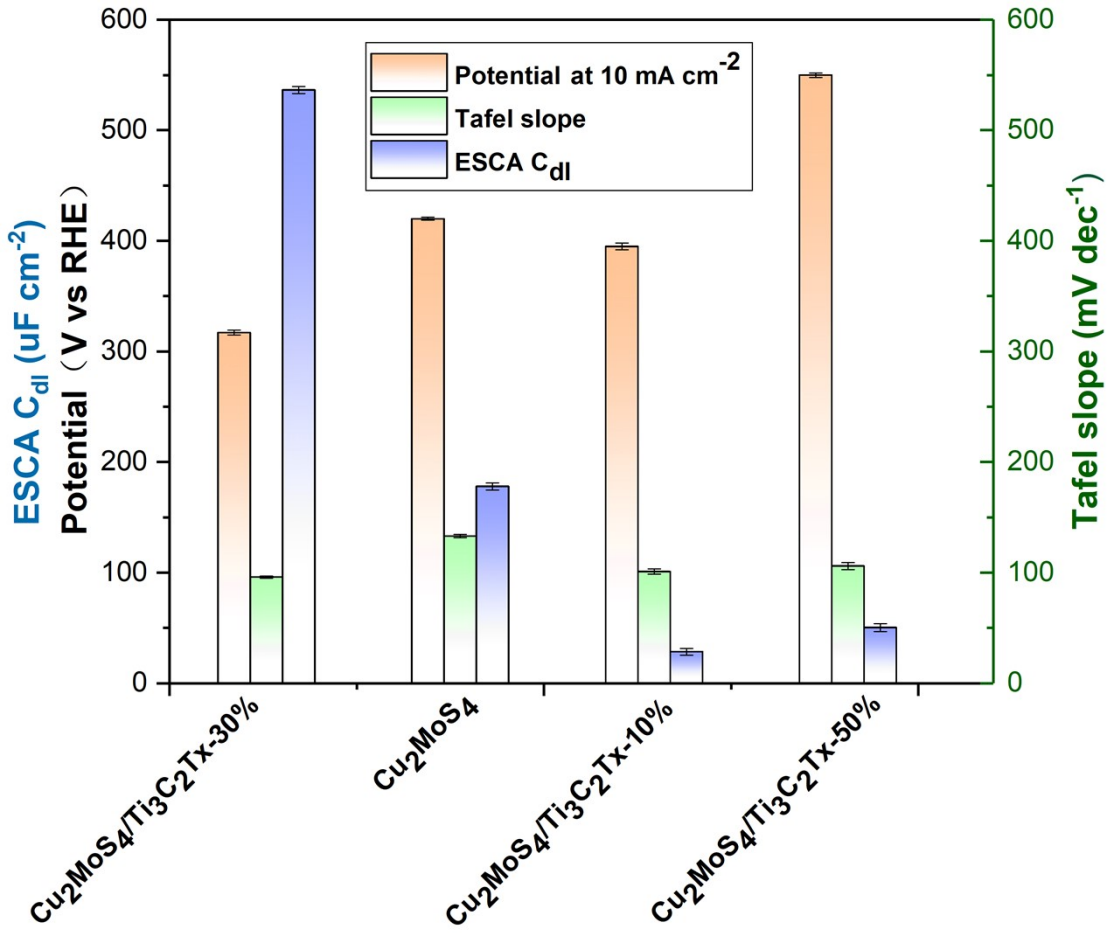


Fig.S4 electrochemical data (Tafel slopes, overpotentials, ECSAs) of $Cu_2MoS_4/Ti_3C_2Tx$-30%, $Cu_2MoS_4$, $Cu_2MoS_4/Ti_3C_2Tx$-10% and $Cu_2MoS_4/Ti_3C_2Tx$-50%

Fig.S4 shows $Cu_2MoS_4/Ti_3C2Tx$-30% has the lowest overpotential, the lowest Tafel slope and the highest ESCAs potential at 10 mA $cm^{-2}$, indicating that $Cu_2MoS_4/Ti_3C_2Tx$-30% has the best catalytic activity, among the four materials. The error bars represent the standard deviations of least three independent measurements of the same sample.

**Table S1** Comparison of recent reported $Cu_2MoS_4$ catalysts for HER in 0.5 M $H_2SO_4$

| Catalyst | Medium (electrolyte) | η (mV) (i=-10 mA cm-2) | Tafel slope (mV $dec^{-1}$) | Reference |
|---|---|---|---|---|
| $Cu_2MoS_4$@$Ti_3C_2T_x$ | 0.5 M $H_2SO_4$ | 317 | 96 | This work |
| $Cu_2MoS_4$ INSs | 0.5M $H_2SO_4$ | 360 | 77 | [1] |
| $Cu_2MoS_4$@MWCNT | 0.5M $H_2SO_4$ | 247 | 48 | [2] |
| $Cu_2MoS_4$@ Ce-MOF | 0.5M $H_2SO_4$ | 360 | 70 | [3] |
| $Cu_2Mo(S_ySe_{1-y})_4$ | 0.5M $H_2SO_4$ | 96 | 52 | [4] |

**References**


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