

## Supporting Information

### Synergistic Effects in NiMnEr-LDH: d-d-f Orbital Overlap Enables Efficient CO<sub>2</sub> Photoreduction

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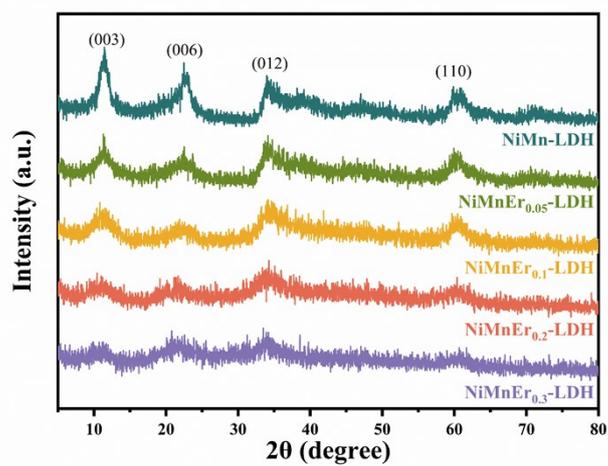
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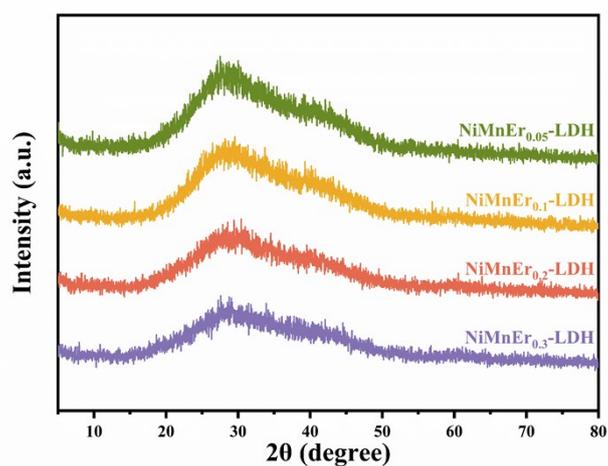
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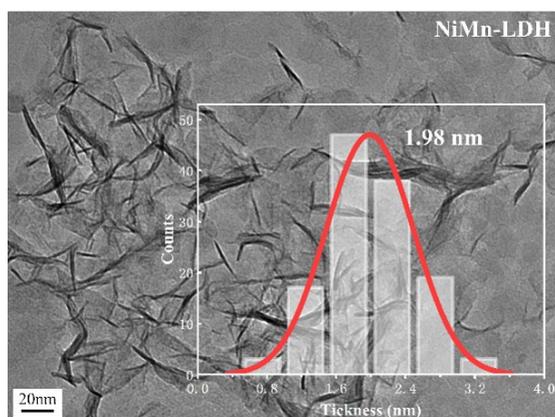
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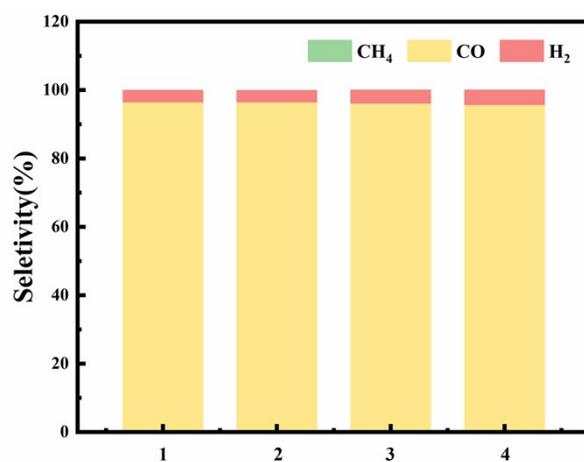
**Figure S1.** XRD patterns of NiMn-LDH and NiMnEr<sub>x</sub>-LDH ( $x=0.05, 0.1, 0.2, 0.3$ )



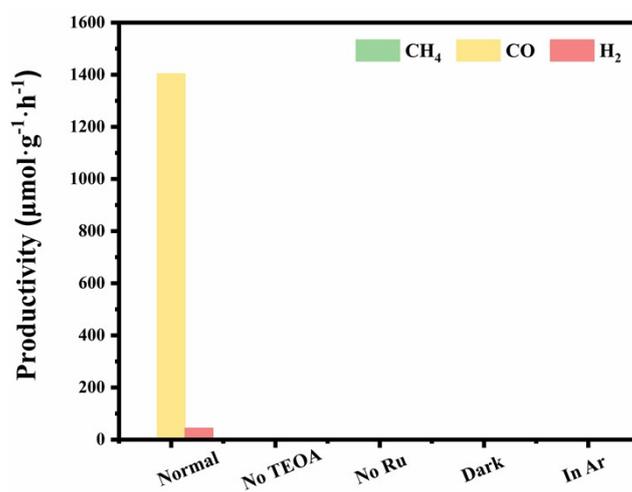
**Figure S2.** XRD patterns of the as-prepared NiMnEr<sub>x</sub>-LDH ( $x=0.05, 0.1, 0.2, 0.3$ )



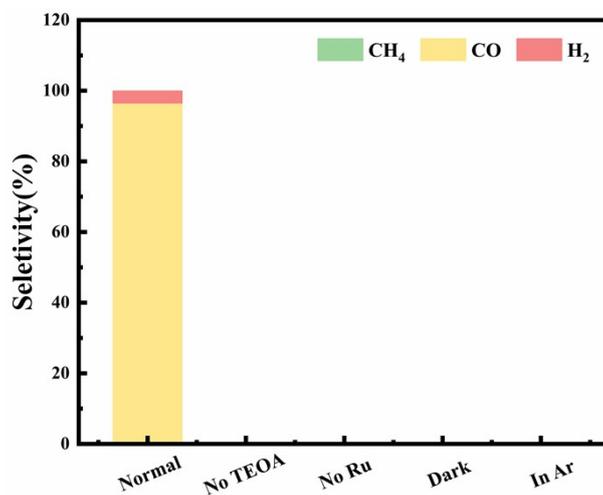
**Figure S3.** HR-TEM image of NiMn-LDH



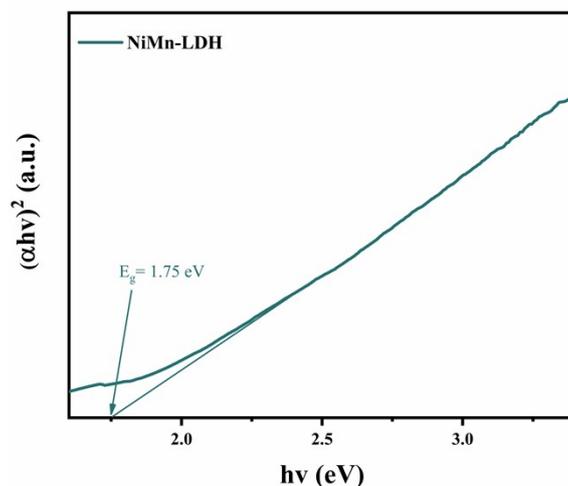
**Figure S4.** The cycling test result (selectivity) of NiMnEr<sub>0.2</sub>-LDH for CO<sub>2</sub>PR.



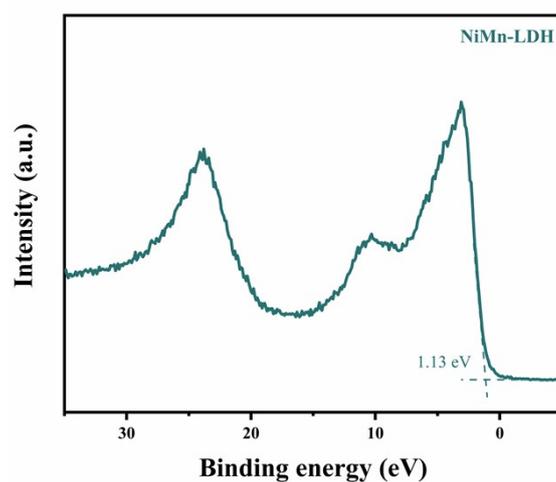
**Figure S5.** The productivity results obtained by varying different factors in the reaction system to examine their effects.



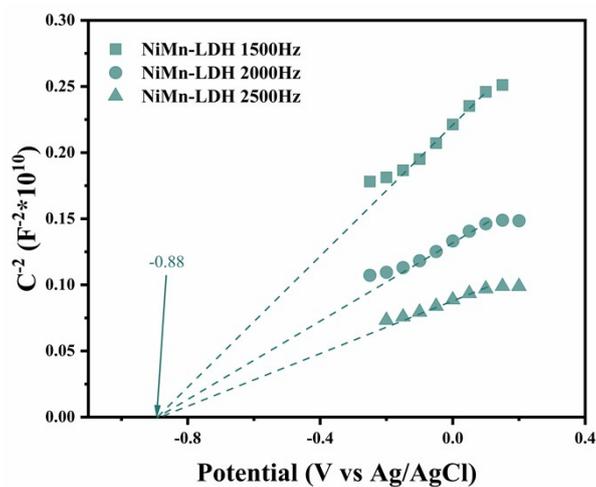
**Figure S6.** The selectivity results obtained by varying different factors in the reaction system to examine their effects.



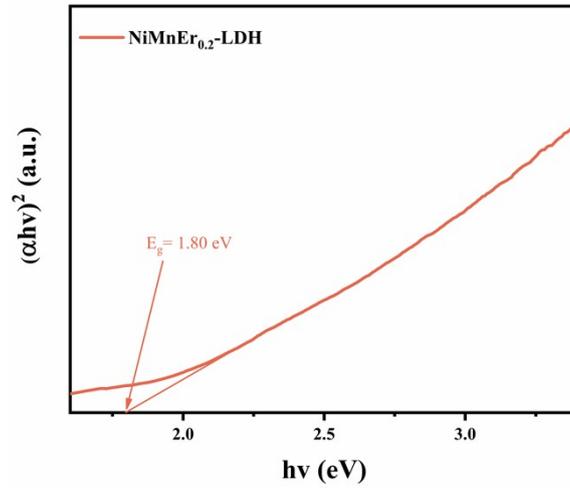
**Figure S7.** The bandgaps calculated based on UV-vis spectra of NiMn-LDH.



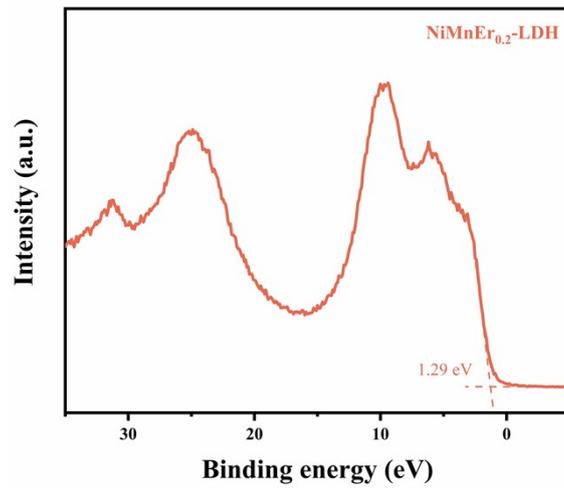
**Figure S8.** The valance band XPS spectra of NiMn-LDH.



**Figure S9.** Mott-Schottky plots of NiMn-LDH.



**Figure S10.** The bandgaps calculated based on UV-vis spectra of NiMnEr<sub>0.2</sub>-LDH.



**Figure S11.** The valance band XPS spectra of NiMnEr<sub>0.2</sub>-LDH.

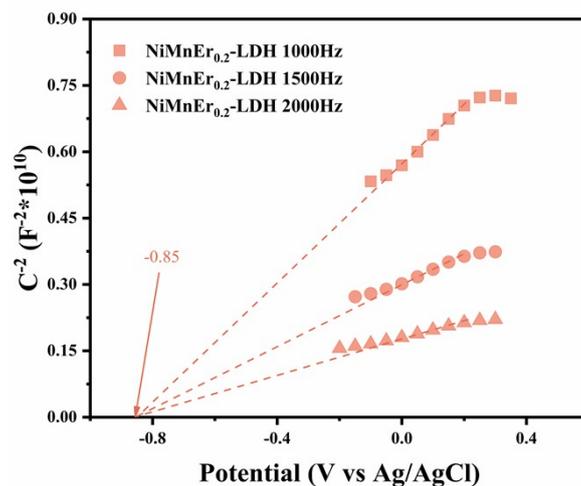


Figure S12. Mott-Schottky plots of NiMnEr<sub>0.2</sub>-LDH.

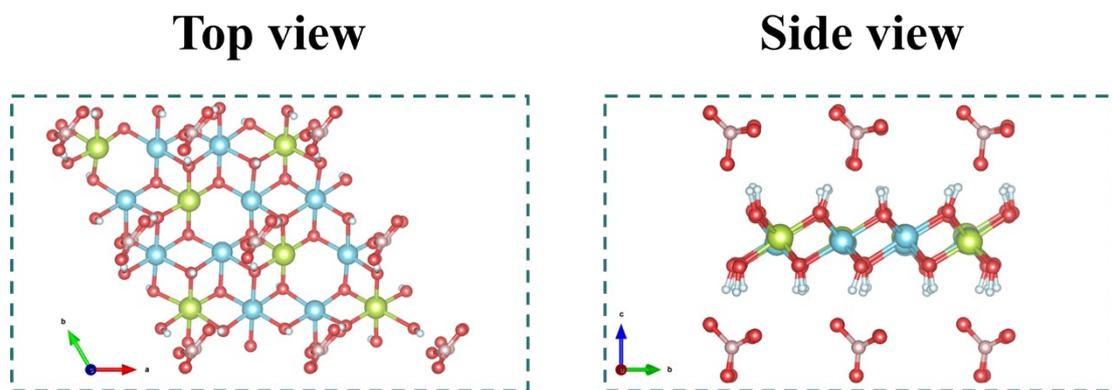


Figure S13. The ball-and-stick structural models of the theoretical calculations of NO<sub>3</sub><sup>-</sup> intercalated NiMn-LDH.

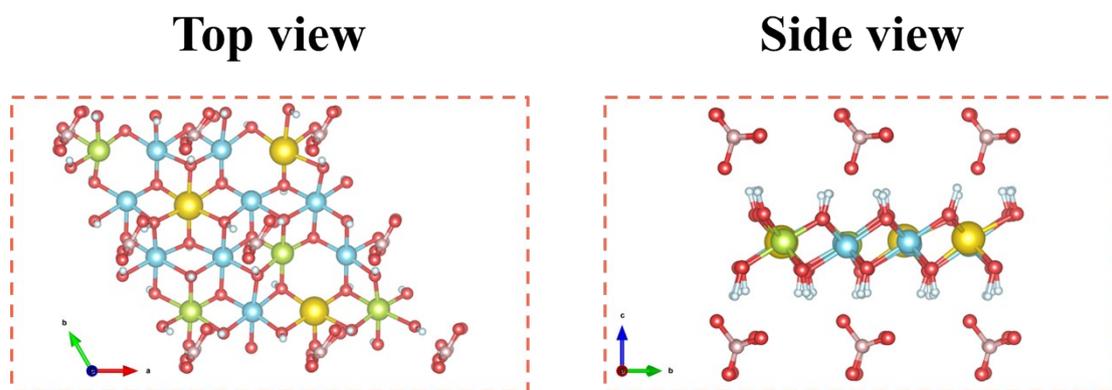


Figure S14. The ball-and-stick structural models of the theoretical calculations of NO<sub>3</sub><sup>-</sup> intercalated NiMnEr-LDH.

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**Table S1.** Elemental content of NiMnEr<sub>0.2</sub>-LDH determined by ICP-OES.

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<b>Catalyst</b>	<b>Ni (wt %)</b>	<b>Mn (wt %)</b>	<b>Er (wt %)</b>
NiMnEr <sub>0.2</sub> -LDH	19.6	7.9	18.8

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