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HIGHLIGHTS

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GRAPHICAL ABSTRACT

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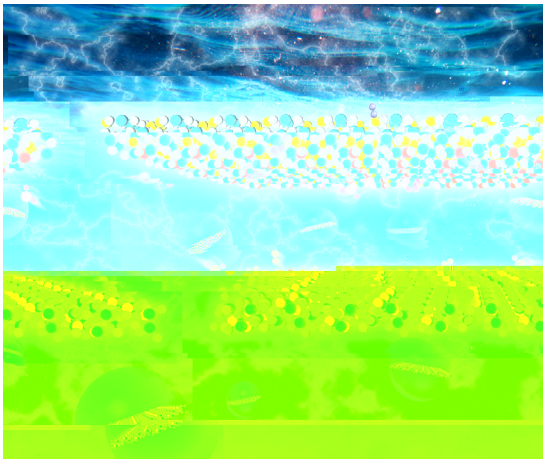

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ABSTRACT

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1. Introduction

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2. Experimental section

2.1. Materials

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/ (20 % , , 1),

- . 2 (%, - , 2),

(%)

/ (20 % , , 1)

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2.2. Synthesis of $Co_2V_2O_7$@NF catalysts

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2.3. Synthesis of a serial of N-doping cobalt vanadium oxide catalysts

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2.4. Synthesis of RuO_2 and 20 wt% Pt/C electrodes

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/ 100 µ

100 µ µ % , .

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2.5. Electrochemical tests

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2.6. Characterization

3. Result and discussion

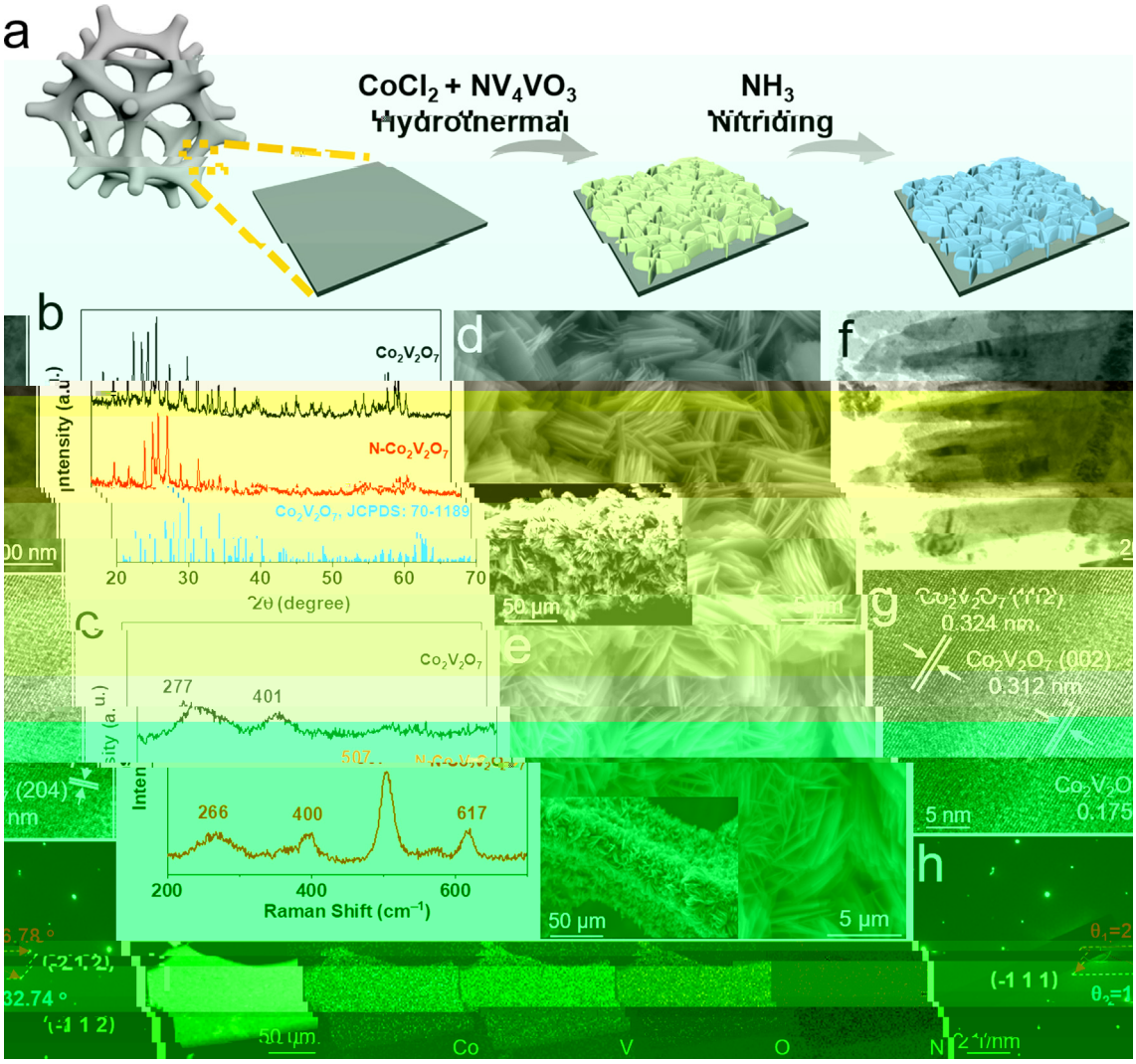

Fig. 1. ( ) i i i i *N-* i i .( ) - i ( ) ( ) 2 2 - 2 2 .(-) i ( ) i 2 2 - 2 2 .( ) i i i ( ), ( ) i - i ( ), ( ) i i ( ) , (i) i — i i i (-) i i i i - 2 2 .

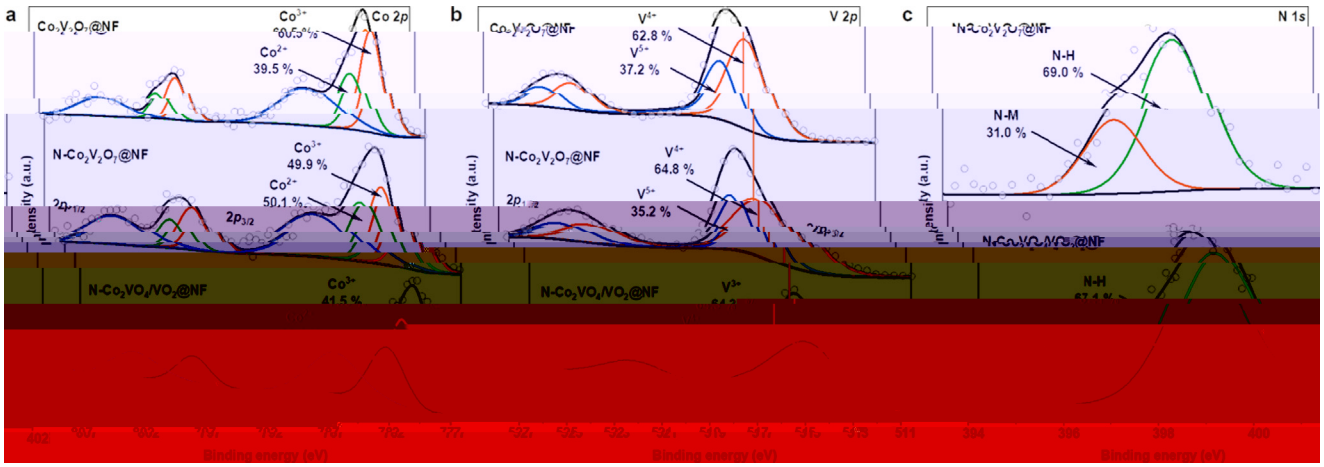

Fig. 2. i - i - ( ) ( ) 2*p*, ( ) 2*p* ( ) 1*s* i 2 2 , - 2 2 - 2 / 2 , i .

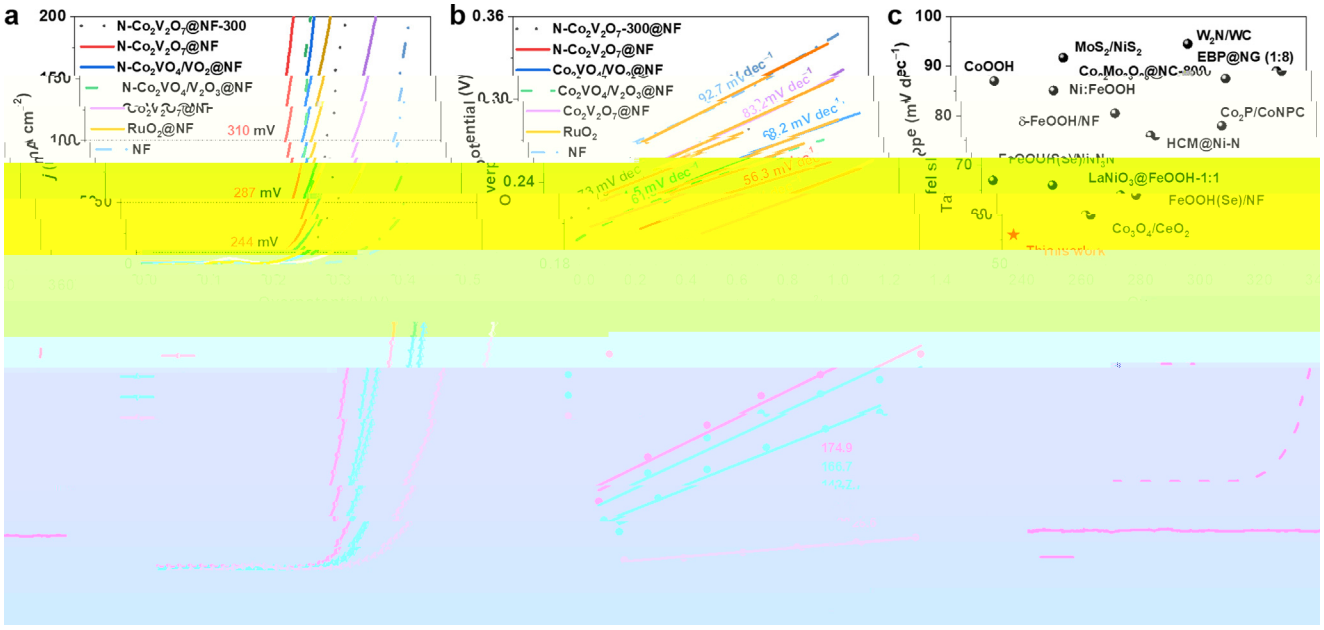

Fig. 3. . ( ) , ( ) , ( ) 10 $^{-2}$ - 2 2 . ( ) ( ) — , ( ) *C* , ( ) 1.0 000).

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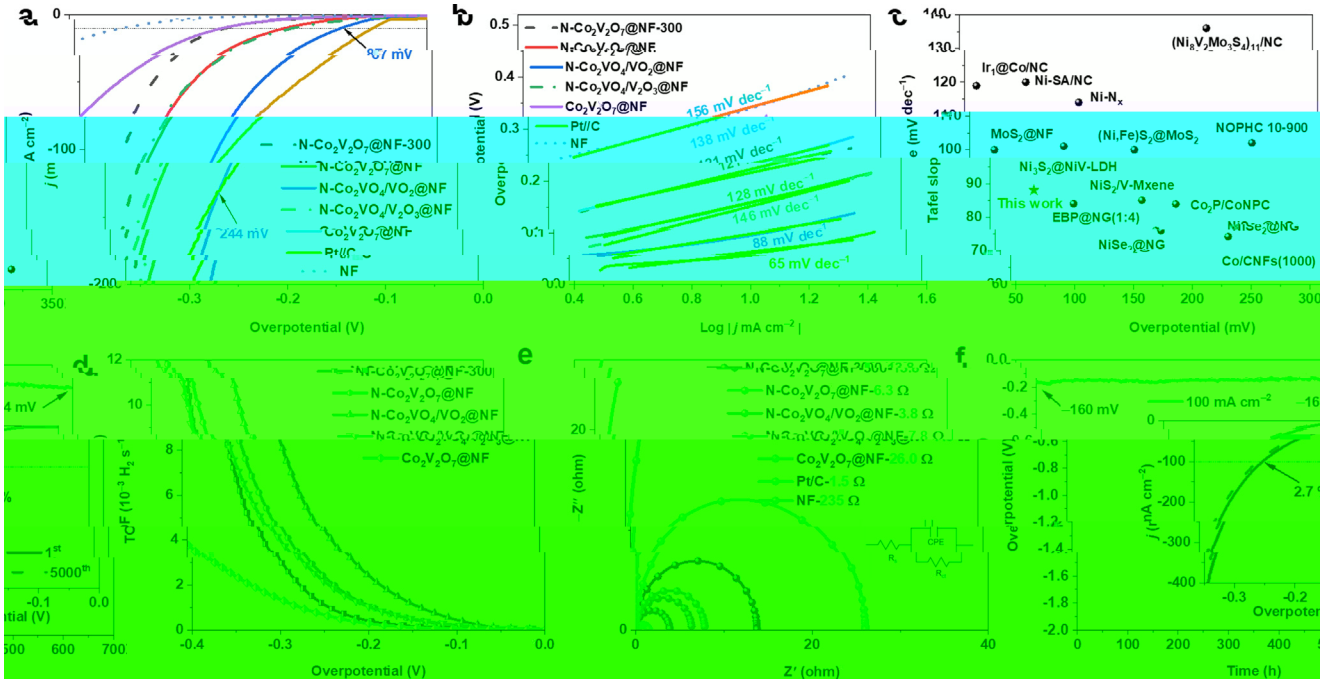

Fig. 4. . ( ) . ( ) . ( ) 10 $^{-2}$ - 2 / 2 . ( ) — . ( )). ( ) 000).

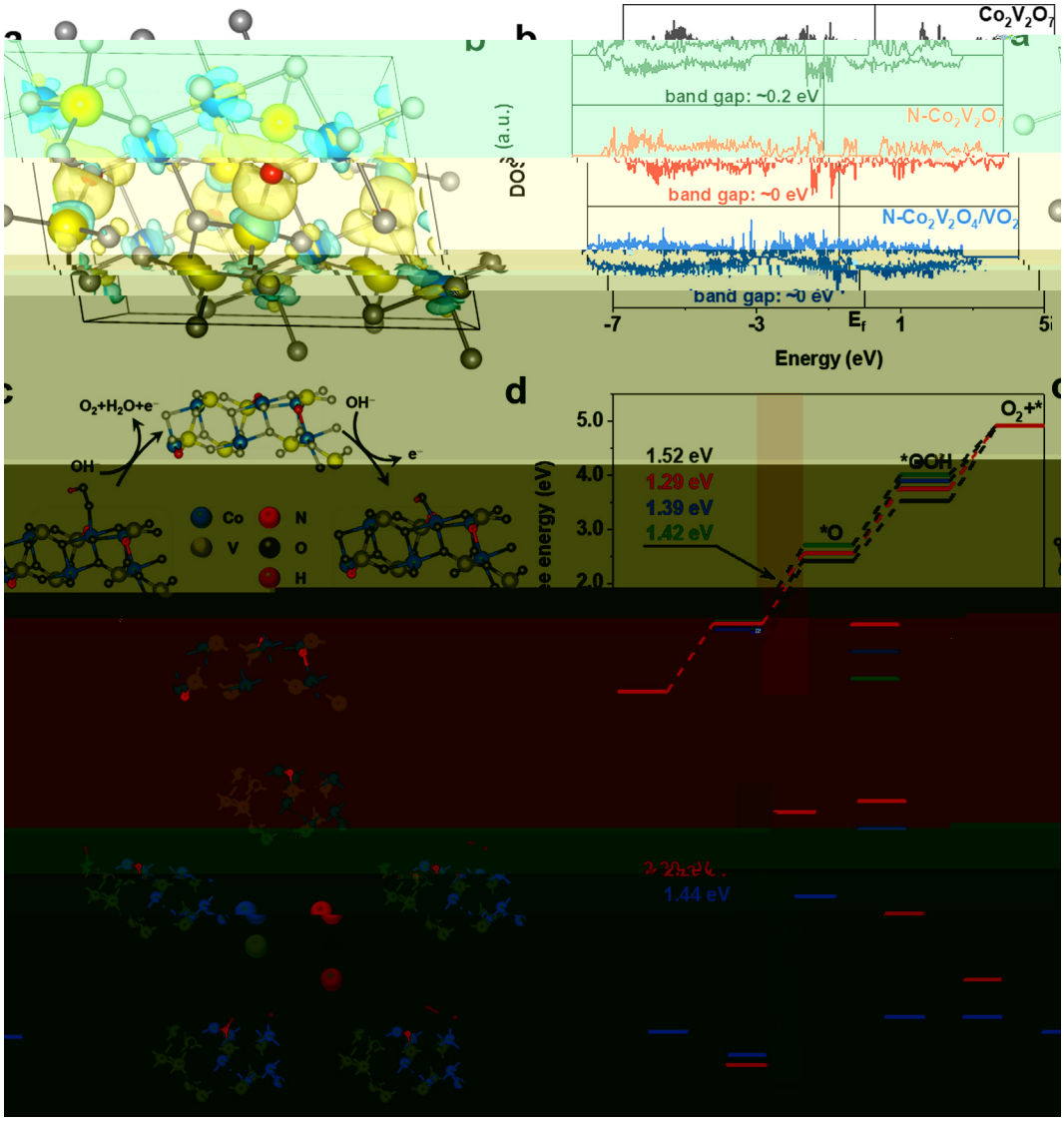

Fig. 5. ( ) i i i i - 2 2 (, , , , , , i . i , i i , i .). ( ) i ( ) i .( ) i i i - 2 2 .( ) i i i .( ) i i i - 2 2 / 2.( ) i i .

4. Conclusion

CRediT authorship contribution statement

Zuyang Luo: **Qimin Peng:** **Zhiyang Huang:** **Lixia Wang:** **Yuting Yang:** **Jiaxin Dong:** **Tayirjan Taylor Isimjan:** **Xiulin Yang:**

Data availability

Declaration of Competing Interest

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(21 00), (201 20 0 , 2020 1200), (209 09), 1 01 , 201 00), (1 12 001).

Data availability

Appendix A. Supplementary material

// /10.101 / . .2022.0 .09 .

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