

# **Addressable surface engineering for N doped WS<sub>2</sub> nanosheet arrays with abundant active sites and optimal local electronic structure for enhanced hydrogen evolution reaction**

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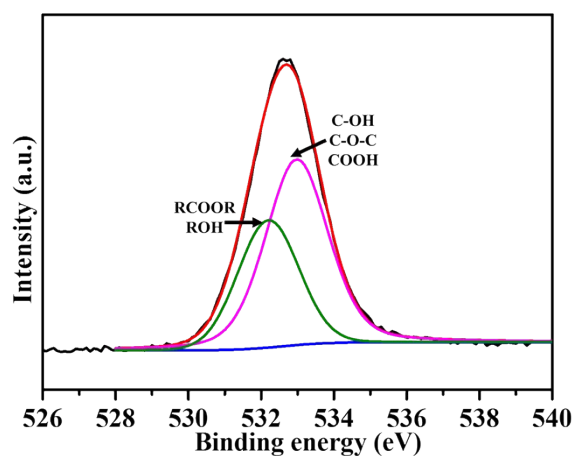


Figure S1 High resolution O 1s of CC-60 sample.

The results is indicative of -O functional groups in hydroxyls, ethers, lactones, and/or carboxyls.

(J. Sanchez, T. R. Hellstern, L. A. King and T. F. Jaramillo, Adv. Energy Mater., 2019, 9, 1901824.)

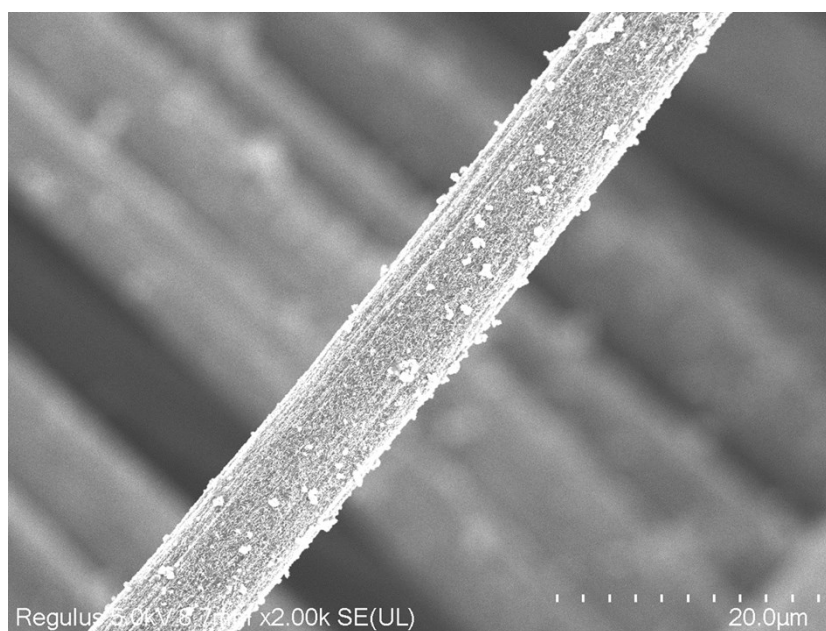


Figure S2. SEM image of WS<sub>2</sub>-CC-60 with low magnification.

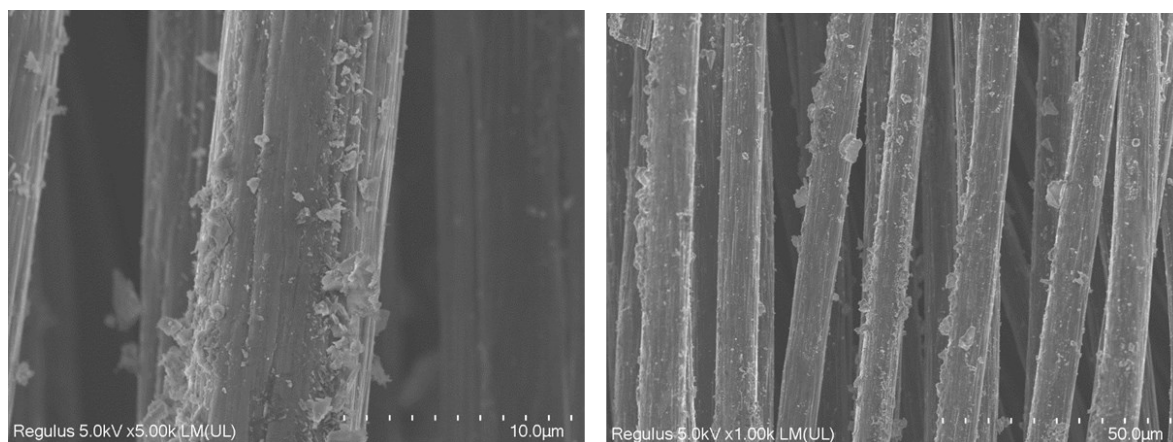


Figure S3. SEM images of WS<sub>2</sub>@mixed acid (HNO<sub>3</sub> and H<sub>2</sub>SO<sub>4</sub>) treated CC.

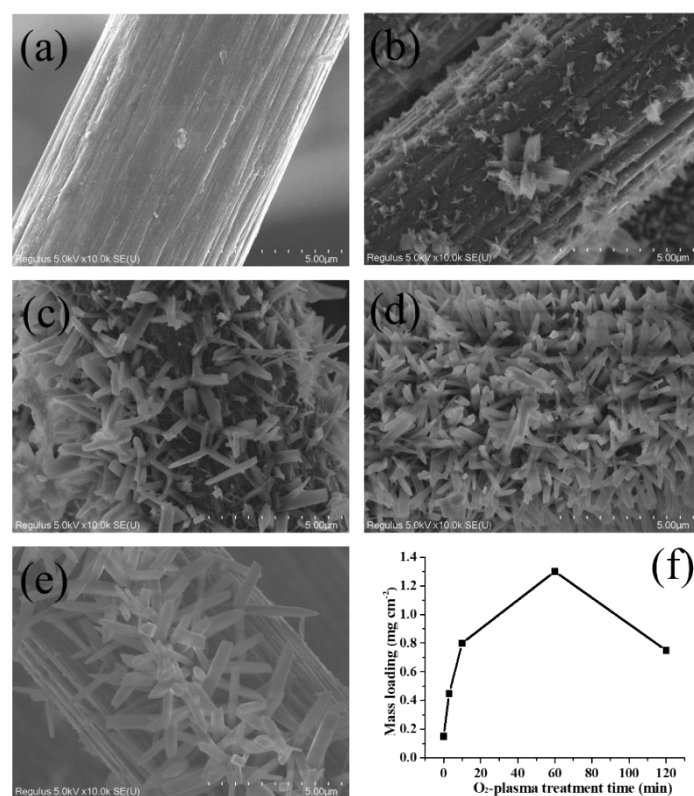


Figure S4. SEM images of Co-MOF-0/3/10/60/120 from a to e.

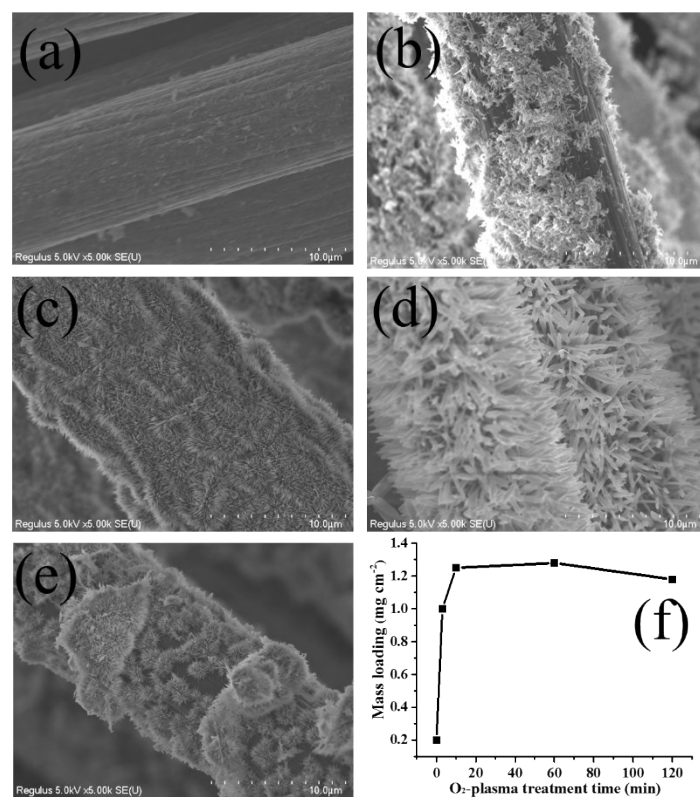


Figure S5. SEM images of NiCoOH/O-0/3/10/60/120 from a to e.

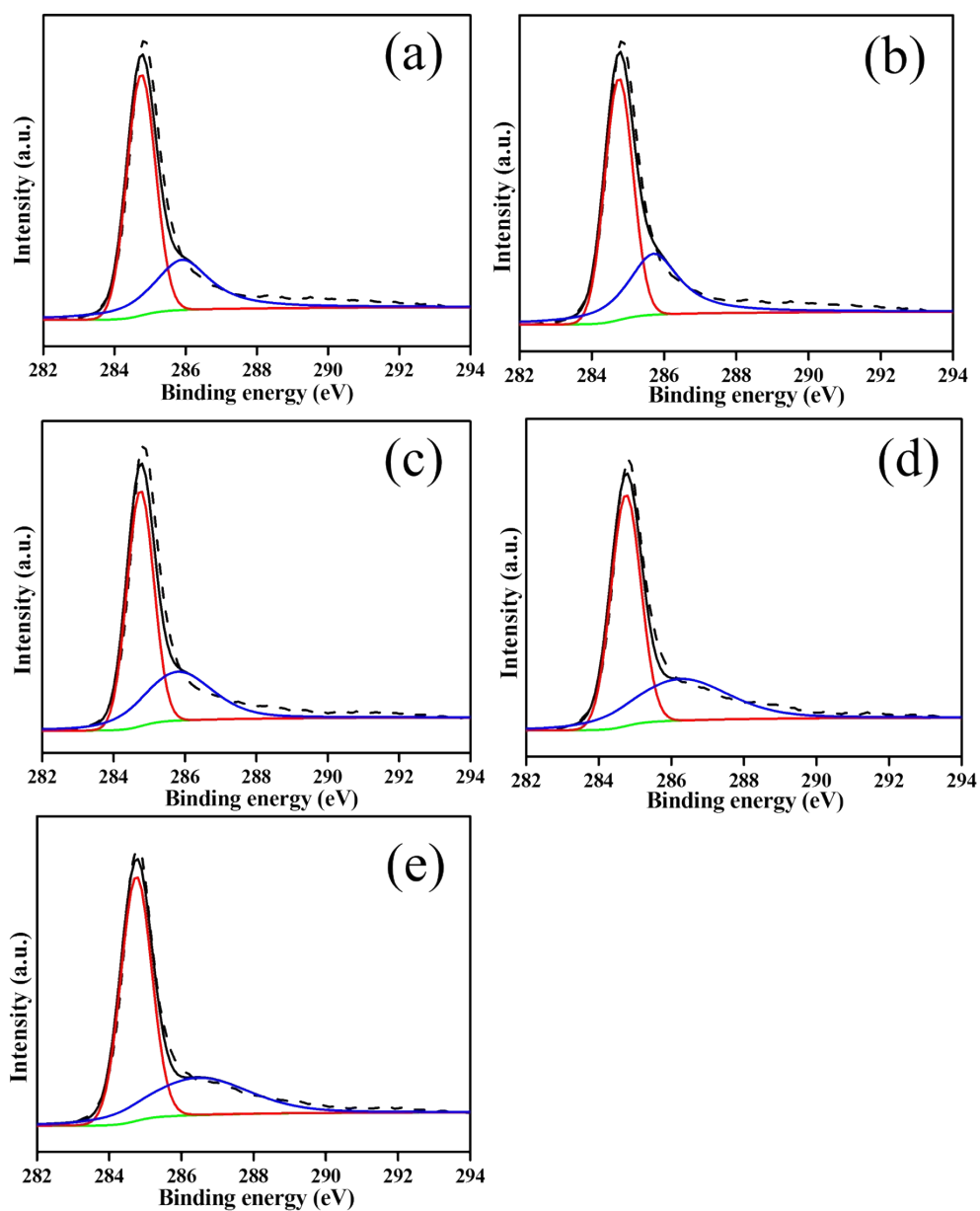


Figure S6. XPS spectra of C 1s peaks of CC-0/3/10/60/120 from a to e, where blue line represents C sp<sup>3</sup> and red line represents C sp<sup>2</sup>.

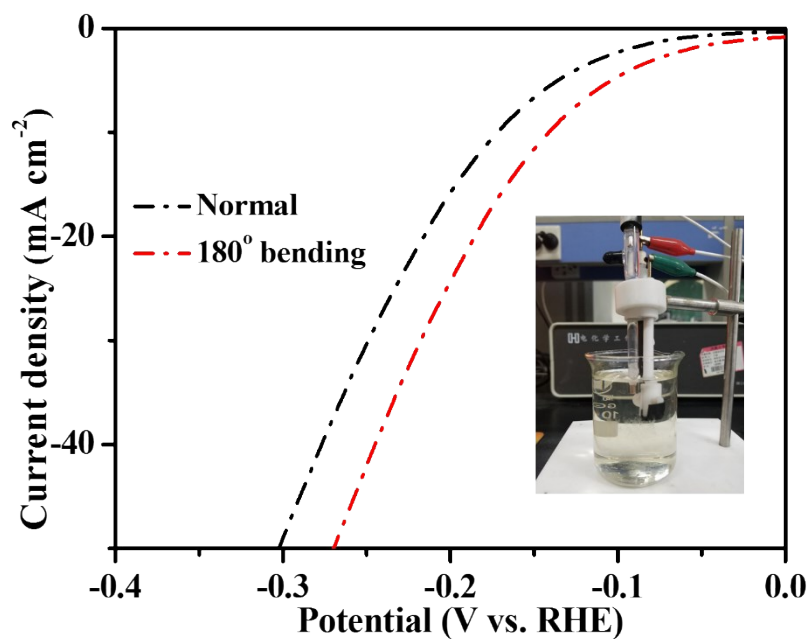


Figure S7. HER performance of N-WS<sub>2</sub> under different bending conditions of 180°

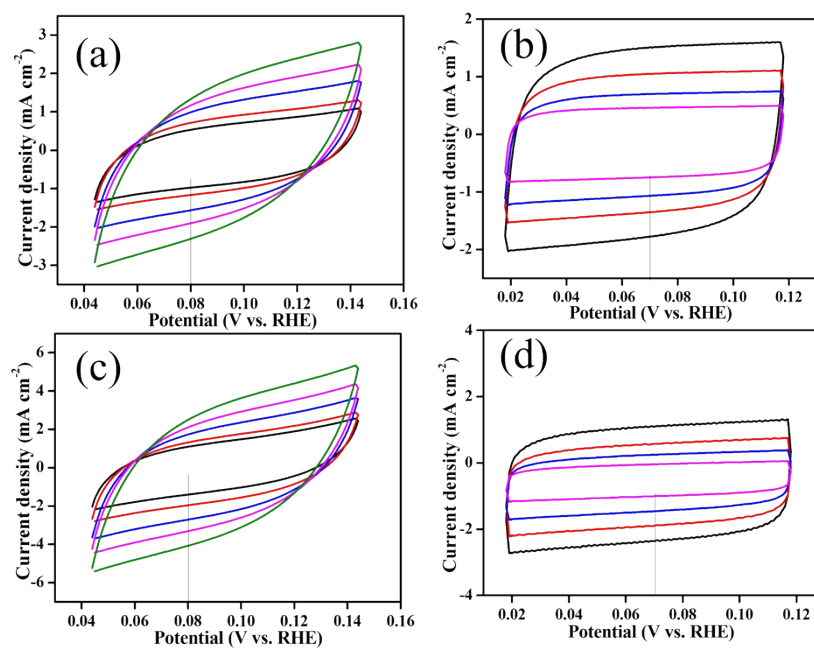


Figure S8 Non-Faradaic scan for double-layer capacitance. (a and c) and (b and d) cyclic voltammetry for acid and alkaline HER, respectively, for measuring  $C_{dl}$  of WS<sub>2</sub> and N-WS<sub>2</sub>.

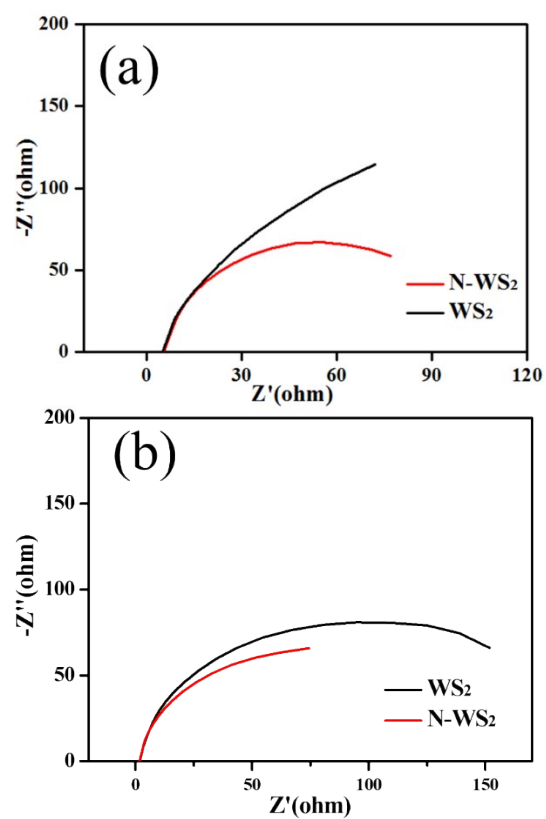


Figure S9 EIS Nyquist plots (a) and (b) of  $WS_2$  and  $N-WS_2$  in alkaline and acid conditions, respectively.

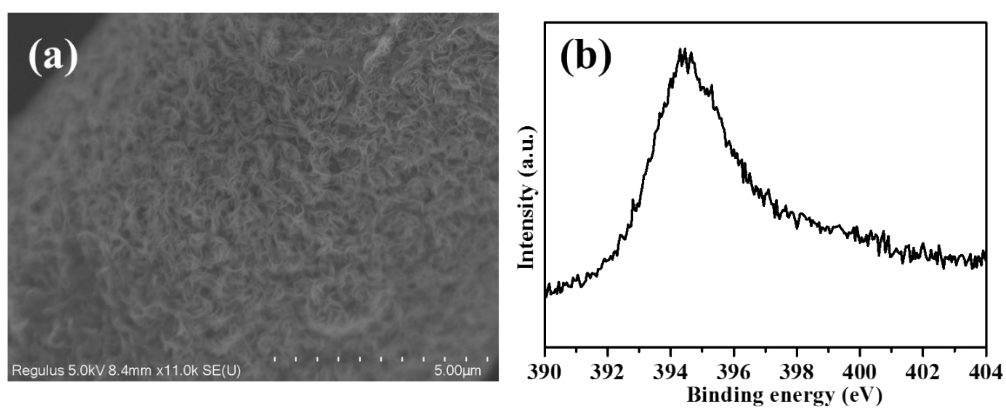


Figure S10 SEM image (a) and high resolution N 1s (b) of  $N-WS_2$  after stability test.