Supporting Information

Vertical-oriented WS_2 Nanosheet Sensitized by Graphene: An Advanced Electrocatalyst for Hydrogen Evolution Reaction

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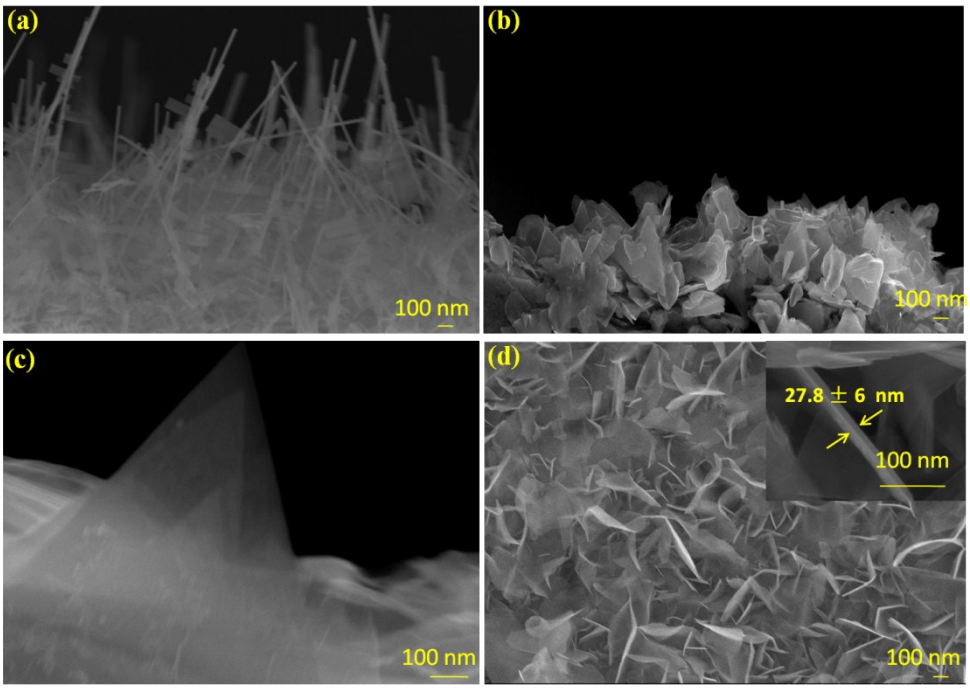

Fig. S1. SEM images side view for (a) WO_3 (b) rGO/ WS_2, (c) magnified for rGO/ WS_2 and (d) top view for rGO/ WS_2

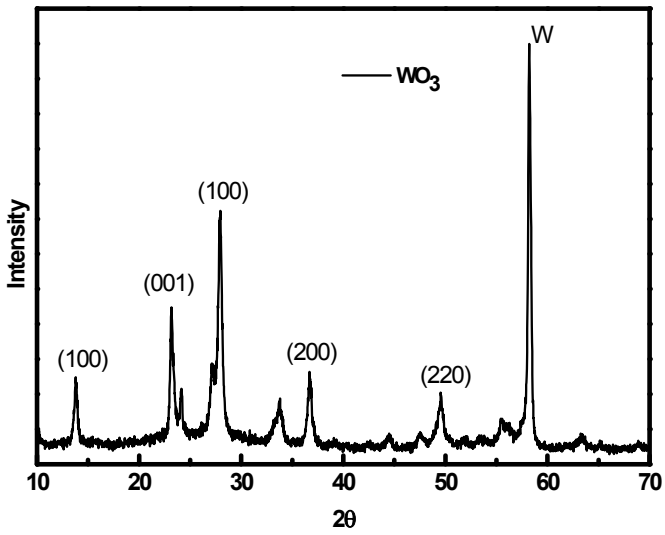

Fig. S2. XRD pattern of WO_3

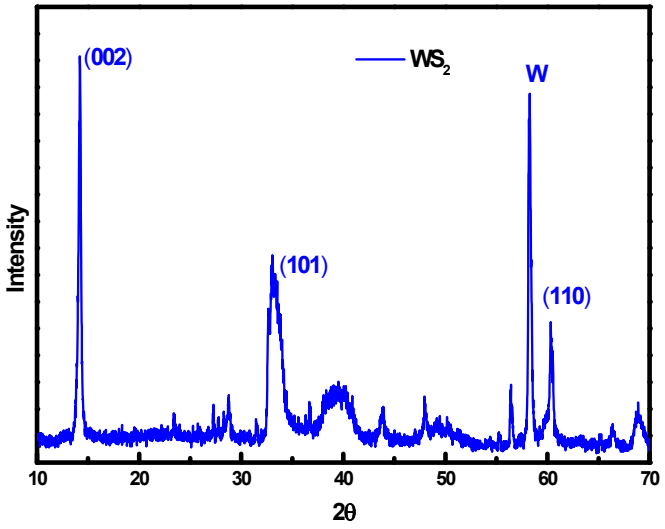

Fig. S3. XRD pattern of WS_2

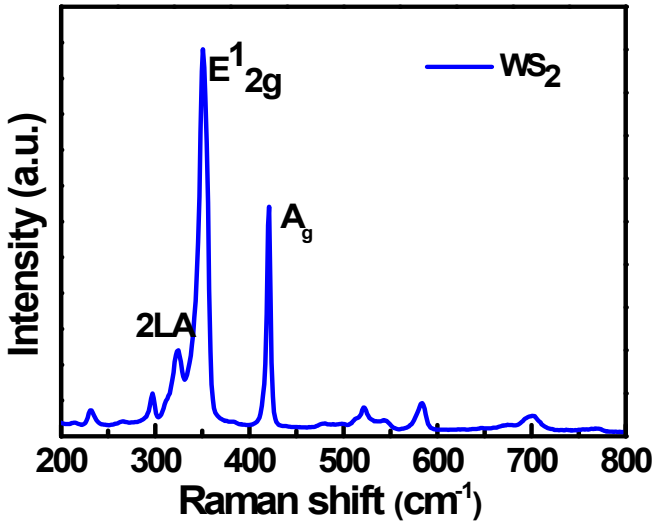

Fig. S4. Raman spectra of WS_2.

Preparation of Reduced Graphene Oxide (rGO).

Graphene oxide was prepared by modified Hummer's method[1]. Briefly, in 500mL Beaker, 200 mg of graphite powder, 100 mg of sodium nitrate, and~5 mL of concentrated H_2SO_4 were mixed and cooled to 0°C in an ice-bath. $KMnO_4$ (600 mg) was added in a stepwise manner to the cooled solution under vigorous stirring keeping the temperature bellow 20 °C. After the complete addition of $KMnO_4$, the temperature of the solution was raised to 35 °C and kept there for half an hour. Then, 10 mL of water was added to the brownish gray paste, and the temperature of the solution rose to 98°C. This temperature was maintained for 15 min, and then the whole solution was diluted further with 30 mL of water and treated with 30% hydrogen peroxide to reduce the residual permanganate and manganese dioxide to colorless soluble manganese sulfate. The light yellow suspension was thoroughly washed with water, air dried and dissolved in distilled water before sonication for 30 min to give ~1 mg/mL GO. The obtained GO was reduced to rGO by treating with 0.5 mL hydrazine hydrate solution[2] and heating at~70−80°C for 2 h.

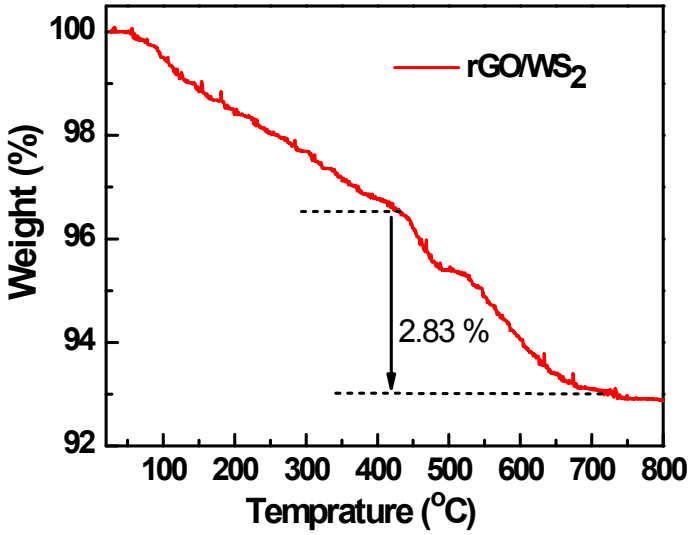

Fig. S5. TGA curve of the rGO/ WS_2 nanosheet made to estimate the composition of the material and its thermal stability thereof, scraped from a 0.52 cm^2 area of the W foil. The steady weight loss in the temperature around 400 °C is due to the thermal decomposition of the oxygen functional groups in rGO and the formation of CO, CO_2, H_2O and C. From the weight loss difference in the TGA curve, the percentage composition of rGO is approximately found to be 2.83%.,

iR-correction

For the sake of accurate comparison of the performances of the catalysts, we corrected the polarization curves for the Ohmic losses. This is made by subtracting the potential loss due to the Rs from the raw potential data following the Ohms's law. The Rs used in this calculation is obtained from the EIS Nyquist plot as the first intercept of the main arc with the real axis. Accordingly, the Rs of samples WS_2 and rGO/WS_2 were 1.29Ω and 0.98Ω respectively.

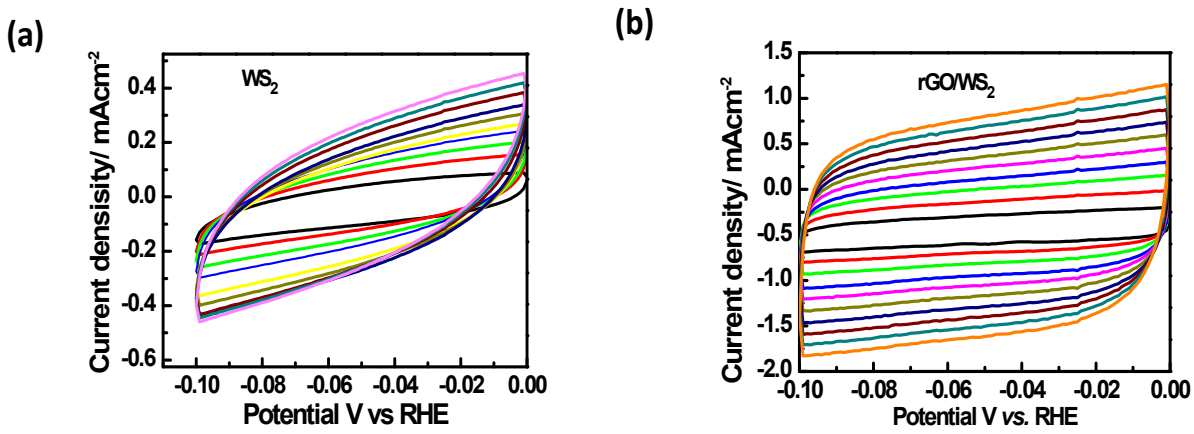

Fig. S5 Voltamograms at various scan rates for estimation of C_{dl} of WS_2 (a) and rGO/WS_2(b)

References

1. W. S. Hummers and R. E. Offeman, *J. Am. Chem. Soc.,* 1958, **80**, 1339-1339.
2. S. K. Bhunia and N. R. Jana, *ACS Appl. Mater. interfaces*, 2014, **6**, 20085-20092.