Supplementary information

Yijie Wang, Wenjie Luo, Haojie Li, and Chuanwei Cheng

Shanghai Key Laboratory of Special Artificial Microstructure Materials and Technology, School of Physics Science and Engineering, Tongji University, Shanghai 200092, P.R. China. E-mail: cwcheg@tongji.edu.cn
Fig S1 (a) XPS survey of Ru/H-S, N-C, Ru/H-N-C, and H-S, N-C; (b) C 1s and Ru 3d spectra; (c) N 1s spectra
Fig S2 The comparison of LSV curves before and after $iR$ correction of Ru/H-S, N-C
Fig S3 CV curves between 0.30 and 0.40 V of (a) Ru/H-S, N-C, (b) Ru/H-N-C, and (c) H-S, N-C
Fig S4 (a) TEM and (b-c) HRTEM images of Ru/H-S, N-C after stability test.
Fig S5 XPS spectra of Ru/H-S, N-C after stability test
Fig. S6 The N$_2$ adsorption and desorption measurements (a) Ru-S, N-C and Ru/H-S, N-C with different diameters of SiO$_2$ as templates (b) 50 nm, (c) 227 nm, and (d) 380 nm
Table S1. Statistic data of yield after each synthesis procedure of Ru/H-S, N-C

| Procedure                        | Weight (mg) | Yield (%) |
|----------------------------------|-------------|-----------|
| Weighing                         | 127.06      | -         |
| Self-assembly & Oil bath         | 107.02      | 84.23     |
| Pyrolysis                        | 78.53       | 73.38     |
| HF etching                       | 6.71        | 8.54      |
Table S2. Element composition of Ru/H-S, N-C and Ru/H-N-C on the basis of TEM-EDS

| Sample          | Element | Wt%  |
|-----------------|---------|------|
| Ru/H-S, N-C     | Ru      | 16.76|
|                 | S       | 2.29 |
|                 | N       | 1.12 |
|                 | C       | 79.83|
| Ru/H-N-C        | Ru      | 13.12|
|                 | N       | 0.43 |
|                 | C       | 86.45|
| Catalysts          | Electrolyte | η_{10} (mV) | Tafel slope (mV dec^{-1}) | loading (mg cm^{-2}) | Ref.   |
|--------------------|-------------|-------------|---------------------------|----------------------|--------|
| Ru/H-S, N-C        | 1.0 M KOH   | 32          | 24                        | 0.35                 | This work |
| Pt/C               | 1.0 M KOH   | 40          | 42                        | 0.35                 | This work |
| Ru⁰/CeO₂           | 1.0 M KOH   | 47          | 41                        | 0.197                | 1      |
| Ru-MoO₂            | 1.0 M KOH   | 29          | 31                        | 0.285                | 2      |
| Cu_{2-x}S@Ru       | 1.0 M KOH   | 82          | 48                        | 0.23                 | 3      |
| NiO/Ru@Ni          | 1.0 M KOH   | 39          | 75                        | -                    | 4      |
| RuP₂@NPC           | 1.0 M KOH   | 52          | 69                        | 1.0                  | 5      |
| S-4                | 1.0 M KOH   | 28          | 31                        | 0.275                | 6      |
| Ru₂Ni₂SNs/C        | 1.0 M KOH   | 40          | 23.4                      | 0.1                  | 7      |
| Ru@SC-CDs 2:10     | 1.0 M KOH   | 29          | 57                        | 0.42                 | 8      |
| Ru₂P@PNC/CC-9 00   | 1.0 M KOH   | 50          | 66                        | 1.5                  | 9      |
| Ni@Ni₂P-Ru HNRs    | 1.0 M KOH   | 41          | 31                        | -                    | 10     |
| SA-Ru-MoS₂         | 1.0 M KOH   | 76          | 21                        | 0.285                | 11     |
| Ru-MoS₂/CNT        | 1.0 M KOH   | 50          | 62                        | 1.0                  | 12     |
| RuS₂/S-GO          | 1.0 M KOH   | 58          | 56                        | 1.0                  | 13     |
| $\text{Ru}_{0.33}\text{Se @ TNA}$ | 1.0 M KOH | 57 | 50 | 0.2 | 14 |
Table S4. The calculation of the atomic ratio of Ru 3p to N 1s of Ru/H-S, N-C before and after the stability test.

| Sample               | Element | Peak Area | Sensitivity Factor | Normalized Area | Atomic Ratio |
|----------------------|---------|-----------|-------------------|----------------|--------------|
| Before stability test| Ru 3p   | 16007.3   | 13.262            | 1207.0         | 0.302        |
|                      | N 1s    | 6693.6    | 1.676             | 3993.8         |              |
| After stability test | Ru 3p   | 7693.1    | 13.262            | 580.1          | 0.305        |
|                      | N 1s    | 3190.6    | 1.676             | 1903.7         |              |
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