Supporting Information

$Ni(OH)_2$-Ag hybrid nanosheets array with ultralow Ag loading as Highly Efficient and Stable Electrocatalysts for Hydrogen Evolution Reaction

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Table S1. Comparison of the HER activity for several recently reported highly active transition metal oxides electrocatalysts in 1.0 M alkaline solution.

Catalyst	Current density (mA/cm^2)	Overpotential (mV)	Electrolyte	Reference
$Ni(OH)_2$-Ag/NF	10	89	1.0M KOH	This work
$Ni(OH)_2@Ni_3S_2$/NF	10	140	1.0M KOH	[S1]
$MoS_2@Ni(OH)_2$/NF	10	134	1.0M KOH	[S2]
$Ni/Ni(OH)_2$	10	168	1.0M KOH	[S3]
$Ni/Ni(OH)_2$-Ag	10	148	1.0M KOH	[S4]

In order to obtain the optimal reaction conditions for the material, a series of controlled experiments were conducted with changing the hydrothermal reaction time and pH value of the mixed solution of silver nitrate and ammonia water. Then the electrocatalytic performances of the obtained catalyst for HER were tested in a conventional three-electrode configuration in 1.0 M KOH aqueous electrolyte, and the temperature was maintained at room temperature. Table S2 shows the results. The reaction time and the pH of the reaction environment do have an effect on the hydrogen evolution performance. It can be found that the lowest HER overpotential of the material at 10 mA·cm^{-2} is obtained when the hydrothermal reaction time is 6 h and the pH of the mixed solution is 7.61, indicating that silver-modified $Ni(OH)_2$ can indeed improve the electrocatalytic activity.

Table S2. HER overpotential at 10 mA·cm^{-2} under different experimental conditions

时间（h）	pH=7.24 HER（mV）	pH=7.40 HER（mV）	pH=7.61 HER（mV）	pH=7.86 HER（mV）
4	148	122	123	154
5	112	128	112	119
6	109	103	89	115
7	120	119	115	113
8	124	123	116	116

Table S1. Table of the mass loading of Ag and Ni by ICP-MS.

Elements	Weight Percent/%
Ag	2.02
Ni	75.32

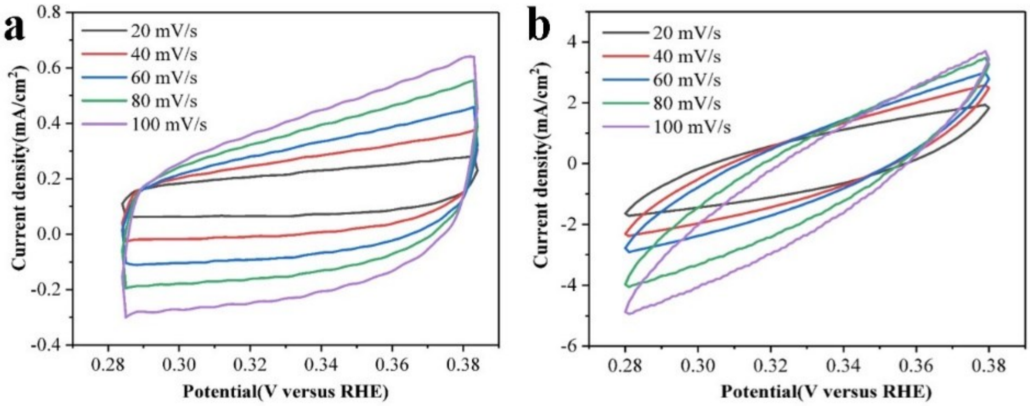

Figure S1. Cyclic voltammograms (CVs) of $Ni(OH)_2$-Ag/NF (a), and$Ni(OH)_2$/NF (b).

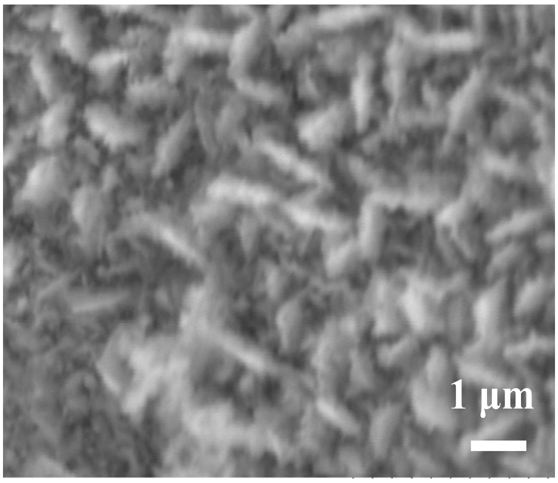

Figure S2. SEM images of $Ni(OH)_2$-Ag/NF after electrolysis.

To compare the LSV curves for the optimal sample in N_2 and H_2 saturated electrolyte, related measurement was implemented and there is little difference between them, shown in Figure S3.

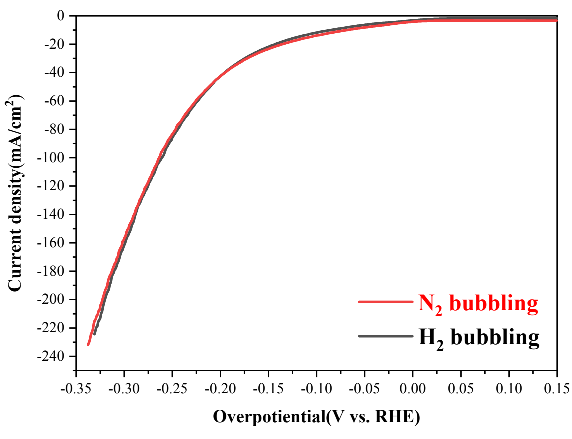

Figure S3. LSV curves in N_2 and H_2 saturated KOH.

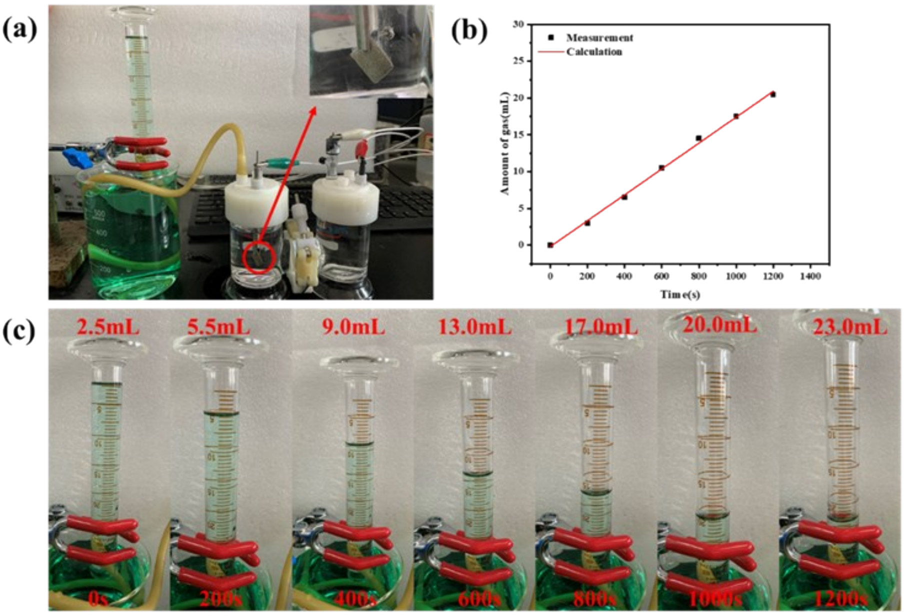

Figure S4. (a) Digital photos of FE test equipment; (b) Amount of experimental and theoretical H2 by Ni(OH)2-Ag/NF (1×1 cm2) at a constant oxidative current of 10 mA; (c) Digital photos of experimental gas evolution's volume change by Ni(OH)2-Ag/NF at a constant oxidative current of 10 mA.

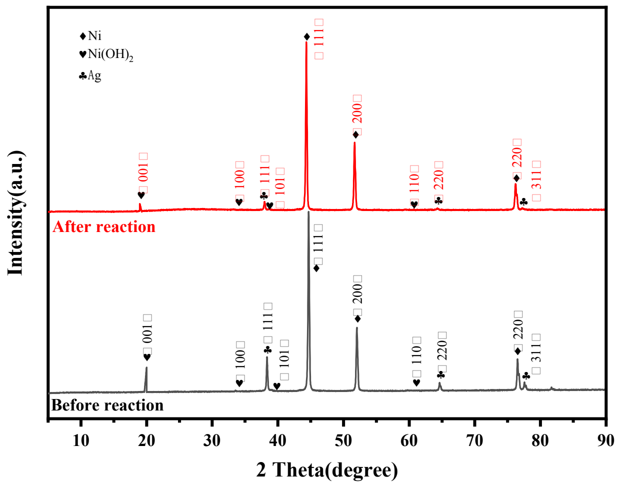

Figure S5. The XRD pattern of Ni(OH)2-Ag/NF before and after stability measurement.

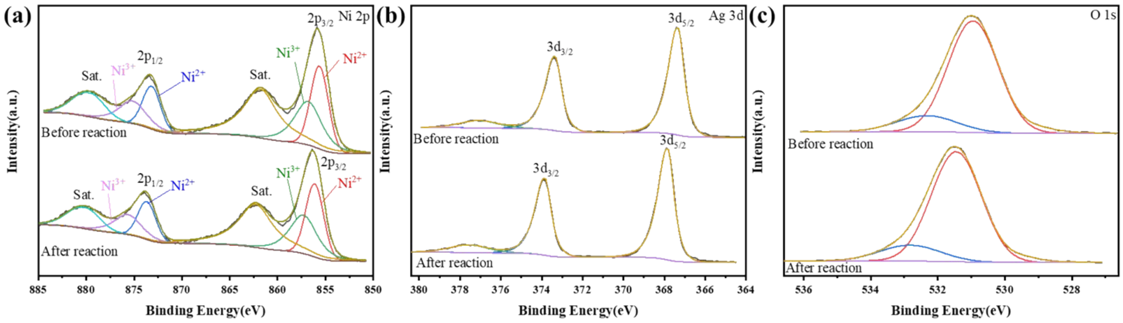

Figure S6. The XPS pattern of Ni(OH)2-Ag/NF before and after stability measurement.

References

[S1] X. Chen, L. Yang, Y. Huang, S. Ge, H. Zhang, Y. Cui, A. Huang, Z. Xiao, *Chem. Eur. J.* 2020, **26**, 1111-1116.

[S2] C. Wei, C. Liu, L. Gao, Y. Sun, Q. Liu, X. Zhang, J Guo, *Journal of Alloys and Compounds*, 2019, **796**, 86-92.

[S3] D. Lim, S. Kim, N. Kim, E. Oh, S. Baeck, *ACS Sustainable Chem. Eng.*, 2020, **8**, 4431-4439.

[S4] L. Zan, H. Zhang, H. Tang, Q. Wei, Y. Zhao, Z. Wang, F. Fu, *Electrochimica Acta*, 2020, **341**, 136051.