Electronic Supplementary Material (ESI) for Dalton Transactions.

Supporting Information

Dual cation-modified hierarchical nickel hydroxide nanosheets arrays as efficient and robust electrocatalysts for urea oxidation reaction

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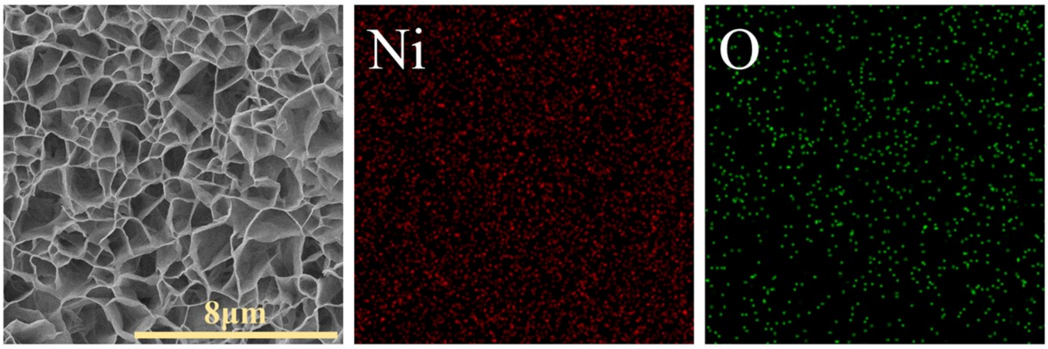

Fig. S1. SEM image and EDS mapping spectrum of $Ni(OH)_2$.

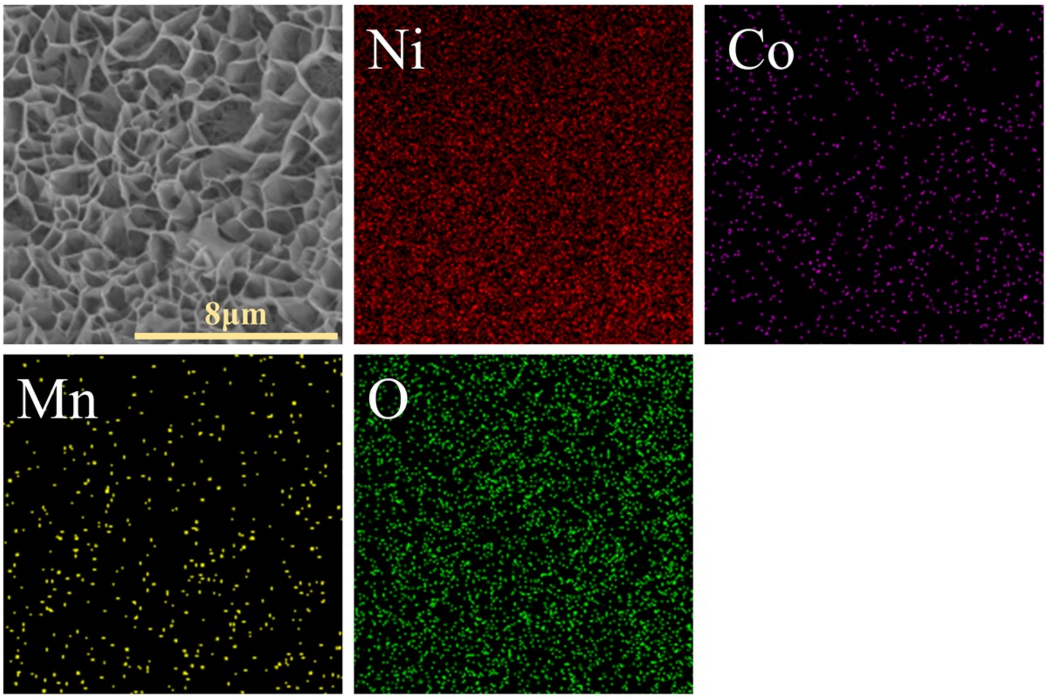

Fig. S2. SEM image and EDS mapping spectrum of $Co/Mn-Ni(OH)_2$.

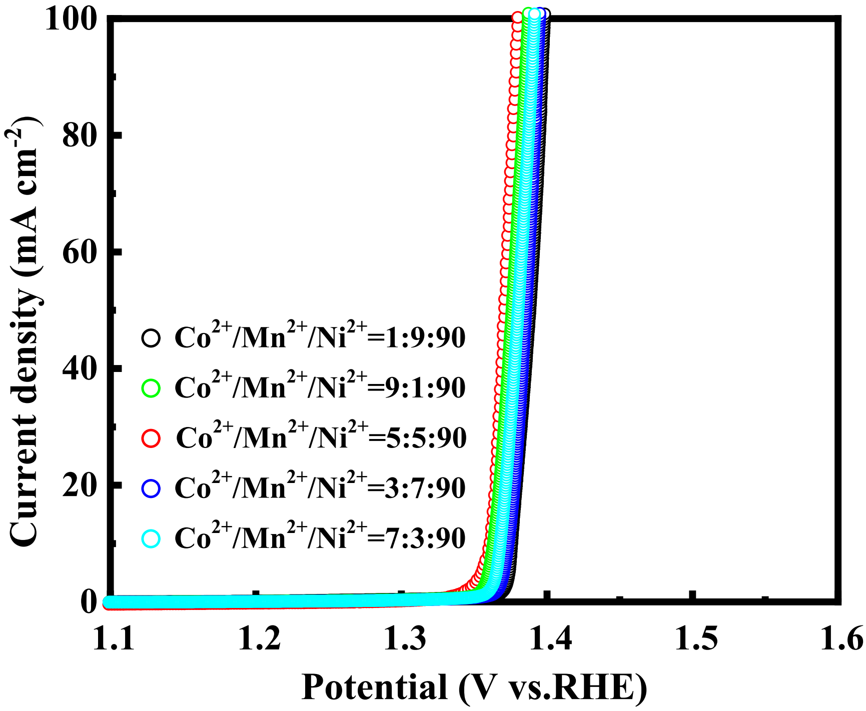

Fig. S3. LSV curves of Co/Mn-Ni$(OH)_2$ catalysts prepared with different ratios of the Co^{2+}:Mn^{2+}:Ni^{2+} in the solution. The Co/Mn-Ni $(OH)_2$ catalysts prepared with the Co^{2+}: Mn^{2+}: Ni^{2+} ratios of 1:9:90, 9:1:90, 5:5:90, 3:7:90 and 7:3:90 in the solution require the potential of 1.398 V, 1.387 V, 1.380 V 1.395 V and 1.391 V to achieve the current density of 100 mA cm^{-2}, respectively.

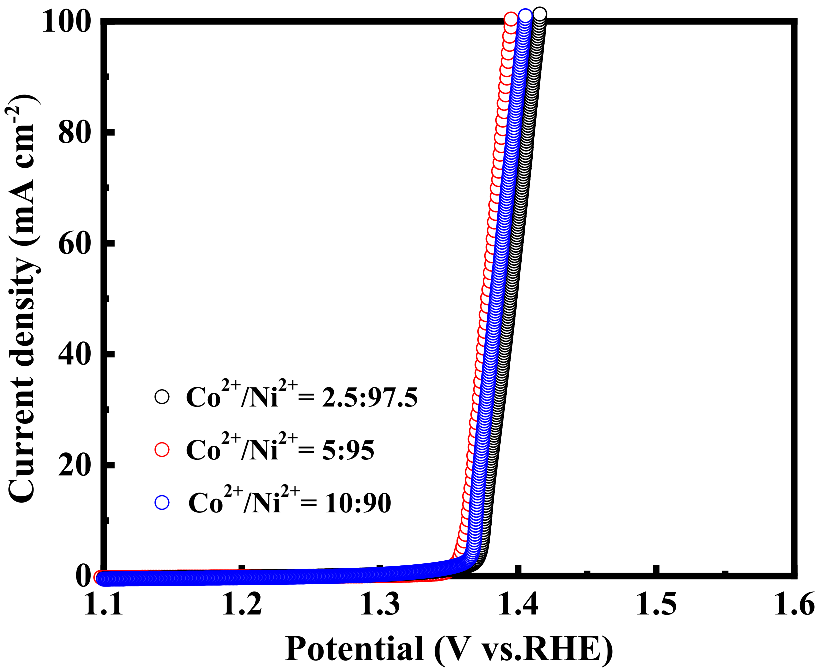

Fig. S4. LSV curves of Co/Mn-$Ni(OH)_2$ catalysts prepared with different ratios of the Co^{2+}:Ni^{2+} in the solution. The Co-Ni $(OH)_2$ catalysts prepared with the Co^{2+}: Mn^{2+}: Ni^{2+} ratios of 2.5:97.5, 5:95, 10:90 in the solution require the potential of 1.415 V, 1.395 V and 1.405 V to achieve the current density of 100 mA cm^{-2}, respectively.

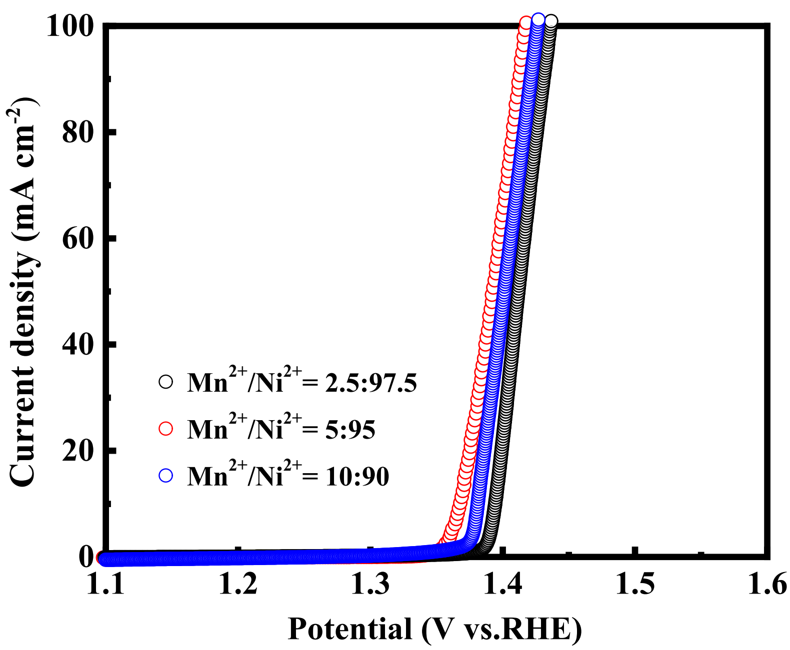

Fig. S5. LSV curves of Mn-Ni$(OH)_2$ catalysts prepared with different ratios of the Mn^{2+}:Ni^{2+} in the solution. The Mn-Ni $(OH)_2$ catalysts prepared with the Mn^{2+}: Ni^{2+} ratios of 2.5:97.5, 5:95, 10:90 in the solution require the potential of 1.436 V, 1.418 V and 1.427 V to achieve the current density of 100 mA cm^{-2}, respectively.

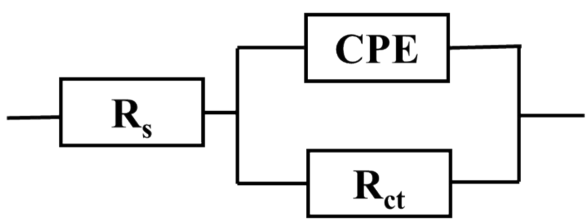

Fig. S6. The equivalent circuit mode. R_s represents the electrolyte resistance. CPE is constant phase element (CPE). R_{ct} is the charge transfer resistance at the interface between the solid-liquid interfaces and is related to the kinetics of the catalytic reaction.

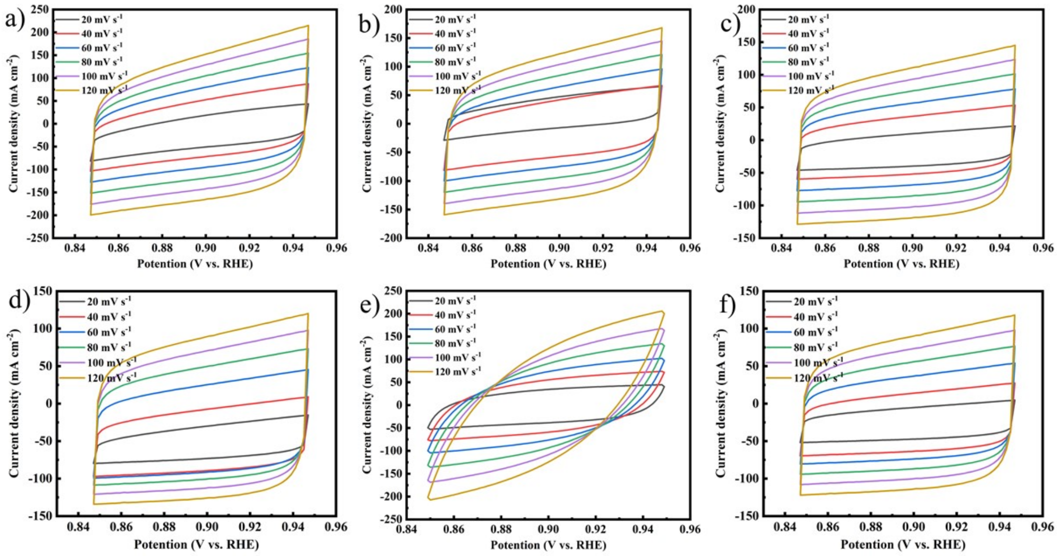

Fig. S7. CV curves of different catalysts at different sweep speeds are as follows: a) Co/Mn-Ni(OH)$_2$, b) Co-Ni(OH)$_2$, c) Mn-Ni(OH)$_2$, d) Ni(OH)$_2$, e) RuO$_2$, f) NF.

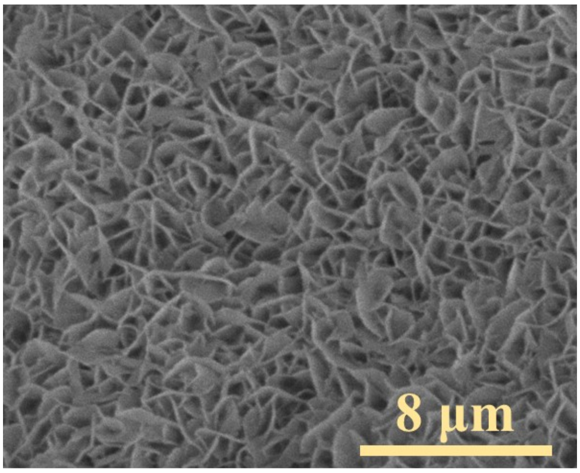

Fig. S8. SEM image of the Co/Mn-Ni$(OH)_2$ after stability test.

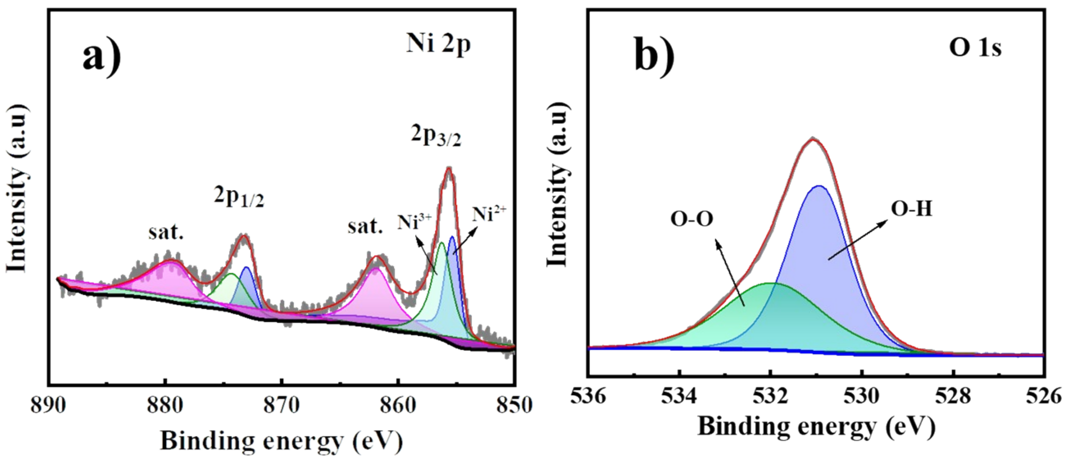

Fig. S9. XPS spectra of a) Ni 2p and b) O 1s of the Co/Mn-Ni$(OH)_2$ after stability test.

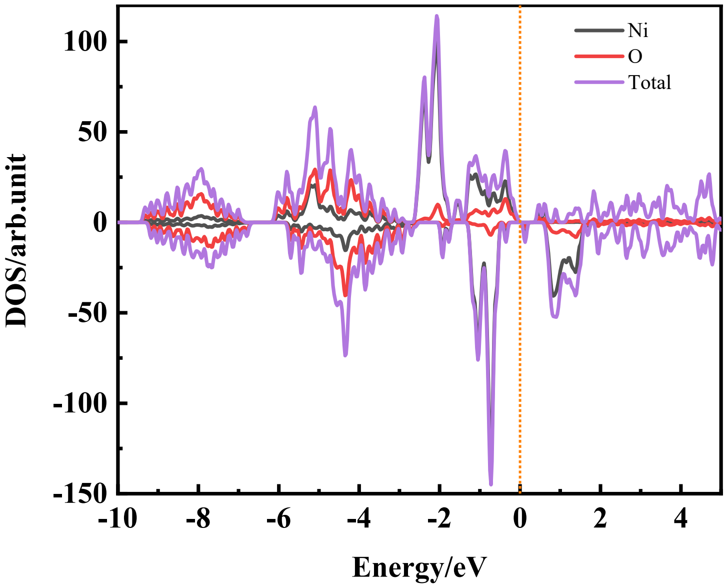

Fig. S10. The DOS of pure $Ni(OH)_2$ sample.

Table. S1 Comparison of this work with other catalysts.

Materials	Electrolyte (KOH + urea)		Potential (V vs. RHE)	Tafel slopes (mV dec^{-1})	Ref
O_{vac}-V-$Ni(OH)_2$/NF	1 M	0.33 M	1.47 @100 mA cm^{-2}	29.12	[1]
SS-NiCo	1 M	0.33 M	1.34 @100 mA cm^{-2}	48.2	[2]
Ni/$NiMoO_x$	1 M	0.33 M	1.355 @20 mA cm^{-2}	24.3	[3]
Ni-S-Se	1 M	0.5 M	1.6 @100 mA cm^{-2}	-	[4]
Ce-Ni_2P	1 M	0.3 M	1.473 @100 mA cm^{-2}	78.4	[5]
Ni、N-$NiMoO_4$ /NF	1 M	0.5 M	1.444 @100 mA cm^{-2}	120	[6]
CoN/$Ni(OH)_2$	1 M	0.5 M	1.39 @50 mA cm^{-2}	64	[7]
Ni^0-rich Ni/NiO	1 M	0.33 M	1.49 @10 mA cm^{-2}	85	[8]
NiS/MoS2@FCP	1 M	0.4 M	1.43 @100 mA cm^{-2}	70	[9]
NiCo-WO_x	1 M	0.33 M	1.38 @100 mA cm^{-2}	28	[10]
This work	1 M	0.33 M	1.38 @100 mA cm^{-2}	35	

Reference

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