Electronic Supplementary Material (ESI) for Nanoscale.

M_XP(M=Co/Ni)@Carbon Core–Shell Nanoparticles Embedded in 3D Cross-linked Graphene Aerogels Derived from Seaweed Biomass for Hydrogen Evolution Reaction

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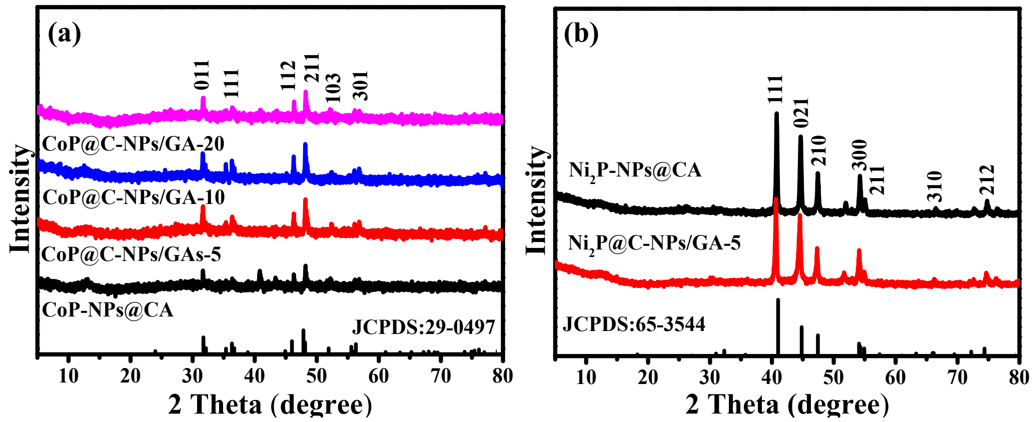

Figure S1 (a) XRD patterns of CoP-NPs@CA and CoP@C-NPs/GA-x, (b) Ni_2P-NPs@CA and Ni_2P@C-NPs/GA-x

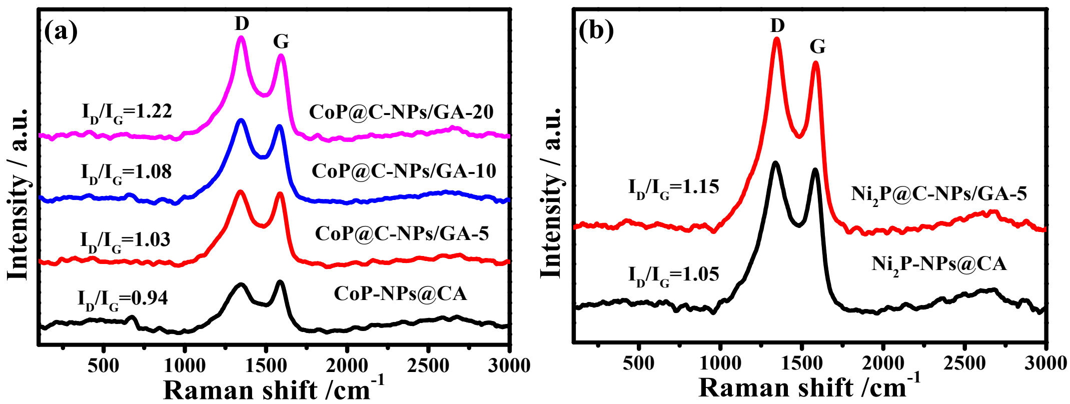

Figure S2 (a) Raman spectra of CoP-NPs@CA and CoP@C-NPs/GA-x, (b) Ni_2P-NPs@CA and Ni_2P@C-NPs/GA-5.

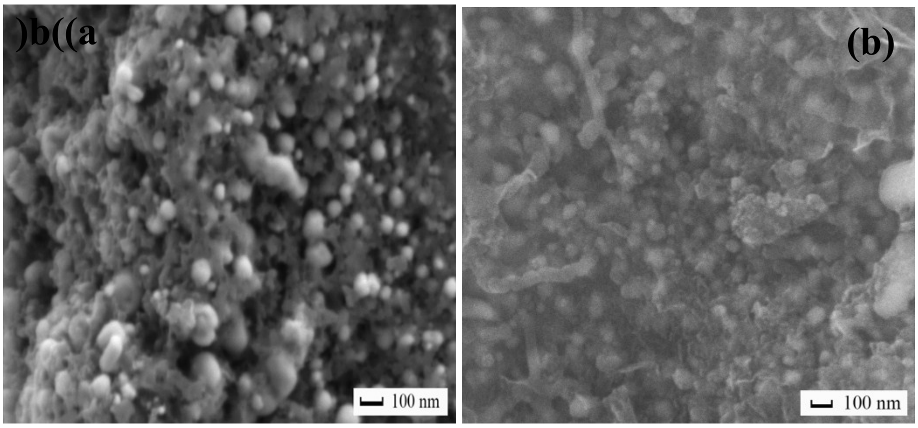

Figure S3 FESEM images of different mass ratio of graphene oxide (a) Ni_2P-NPs@CA, (b) Ni_2P@C-NPs/GA-5.

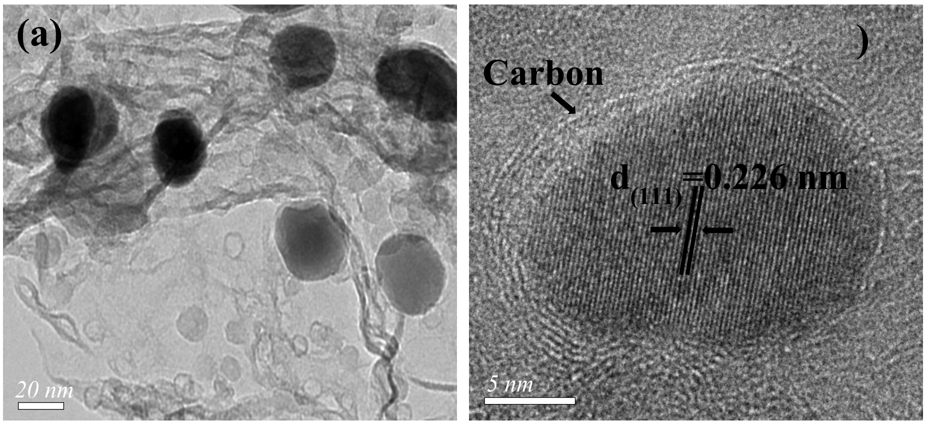

Figure S4 (a) High-magnification TEM images of the synthesized Ni_2P@C-NPs/GA-5, (b) HRTEM images of Ni_2P@C-NPs/GA-5.

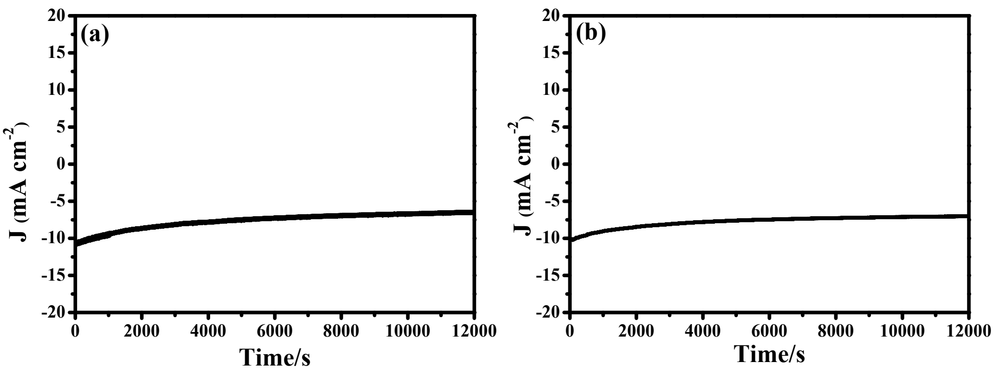

Figure S5 Stability tests of Ni_2P@C-NPs/GA-5 using the chronopotentiometric measurements (without iR corrections) with the fixed current density of 10 mA cm^{-2} in (a) 0.5 M H_2SO_4 and (b) 1 M KOH solutions.

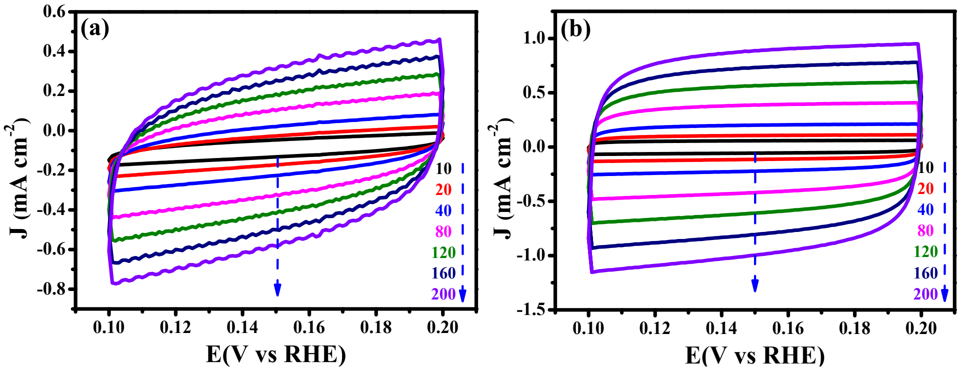

Figure S6 CVs performed at various scan rates in the region of 0.10–0.20 V versus RHE for CoP-NPs@CA electrocatalyst (a) in 0.5 M H_2SO_4 electrolytes and (b) in 1 M KOH electrolytes.

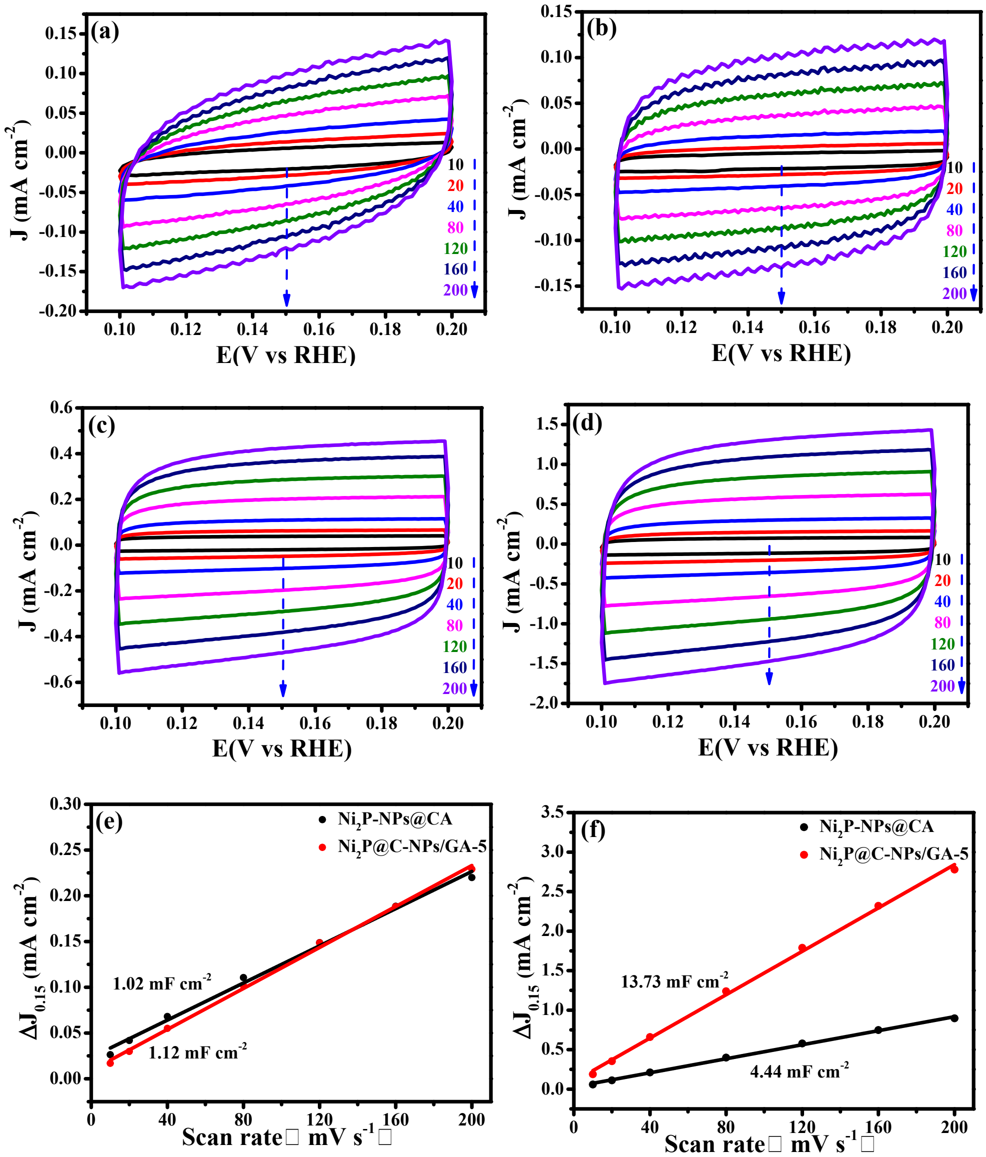

Figure S7 CVs performed at various scan rates in the region of 0.10–0.20 V versus RHE for Ni_2P-NPs@CA (a) in 0.5 M H_2SO_4 electrolytes and (c) in 1 M KOH electrolytes, Ni_2P@C-NPs/GA-5 (b) in 0.5 M H_2SO_4 electrolytes and (d) in 1 M KOH electrolytes. Ni_2P-NPs/CA and Ni_2P@C-NPs/GA-5 in current density at 0.15 V versus RHE plotted against the scan rate and ftted to a linear regression allows for the estimation of C_{dl} (e) in 0.5 M H_2SO_4 electrolytes and (f) in 1 M KOH electrolytes.

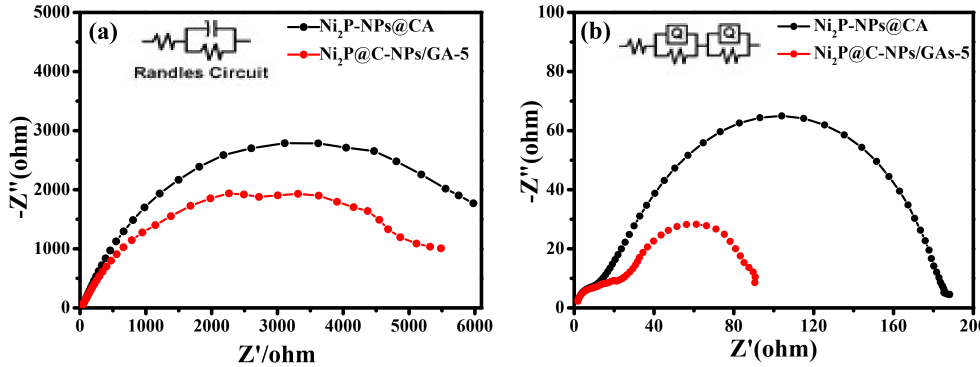

Figure S8 Nyquist plots of Ni_2P-NPs@CA and Ni_2P@C-NPs/GA-5 over the frequency range from 100 kHz to 0.1Hz (a) at η=135 mV with an AC voltage of 10 mV in in 0.5 M H_2SO_4 electrolytes,(b) at η=377 mV with an AC voltage of 10 mV in 1 M KOH electrolytes.

Table S1 Comparison of catalytic parameters of different HER catalysts in 0.5 M H_2SO_4 .

	Loading (mg.cm^{-2})	η_{10} (mV)	Tafel slop (mV dec^{-1})	C_{dl} (mF cm^{-2})	Reference
Porous CoP concave polyhedron	0.35	133	51	/	1
CoP@C	0.31	130	64	9.30	2
CoP@NC-T	0.31	124	59	9.90	2
CoP Hollow Polyhedron	0.10	159	59	/	3
CoP/CNTs	/	139	52	/	4
Co@NC/NG	0.29	/	79	37.30	5
Co@NGF	0.28	125	94	/	6
Ni_2P/N-doped Graphene	0.18	102	59	/	7
$CoSe_2$@DC	0.36	132	82	51.10	8
Ni_5P_4-Ni_2P nanosheet	68.2 (electrode)	120	79	/	9
$Ni_{12}P_5$/CNT	0.18	240	81	/	10
MoP	0.36	125	54	/	11
Mo_2C@NC	0.28	124	60	73.20	12
SV-MoS_2	/	170	60	/	13
CoP NPs	0.35	221	87	/	14
Free CoP NPs	/	167	88	2.57	15
CoP-RGO	/	157	70	5.23	15
Mo_3S_{13}@rGO-CNTs	/	179	67	/	26
aerogels					
GCA-$MoSe_2$-2 aerogels	/	228	68	1.31	27
$MoSe_2$ /carbon fiber aerogel	/	179	62	/	28
CoP@C-NPs/GA-5	0.28	120	57	55.83	Our work

Table S2 Comparison of catalytic parameters of different HER catalysts in 1 M KOH.

	Loading ($mg.cm^{-2}$)	η_{10} (mV)	Tafel slop ($mV\ dec^{-1}$)	C_{dl} ($mF\ cm^{-2}$)	Reference
CoP@C	**0.31**	**170**	**83**		**2**
CoP/NF	**/**	**182**	**109**	**/**	**16**
CoP nanowire arrays/CC	**0.92**	**209**	**129**	**/**	**17**
CoP nanoparticle/Ti	**0.18**	**170**	**66**		**18**
NiMoN/CC	**1.10**	**109**	**95**	**21**	**19**
Ni-P/CP	**25.80**	**117**	**85**		**20**
FeP nanorod arrays/CC	**1.50**	**218**	**146**	**/**	**21**
NiFeVS/NF	**38.25 (electrode)**	**161**	**96**	**32.30**	**22**
WP_2	**/**	**225**	**84**		**23**
Lepidocrocite VOOH hollow nanospheres	**0.80**	**164**	**104**		**24**
Fe_2O_3/Fe@CN	**0.28**	**330**	**114**	**16.20**	**25**
CoP@C-NPs/GA-5	**0.28**	**225**	**66**	**18.85**	**Our work**

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