Electronic Supplementary Material (ESI)

Ni-foam supported Co(OH)F and Co-P nanoarrays for energy-efficient hydrogen production via urea electrolysis

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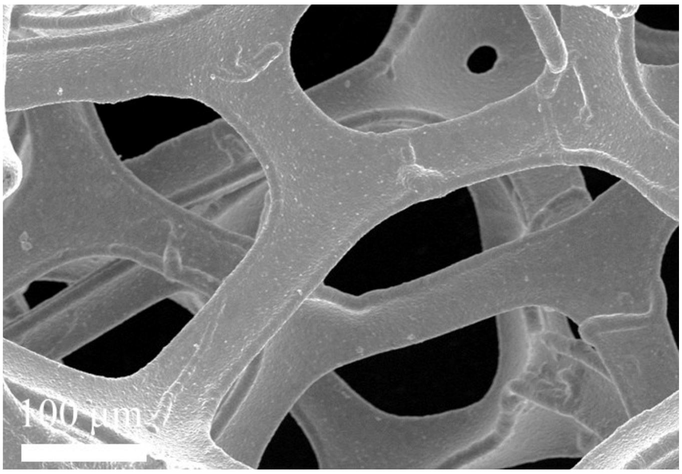

Figure S1. SEM image of Ni foam.

Figure S2. Images of Ni foam, Co(OH)F/NF and Co-P/NF.

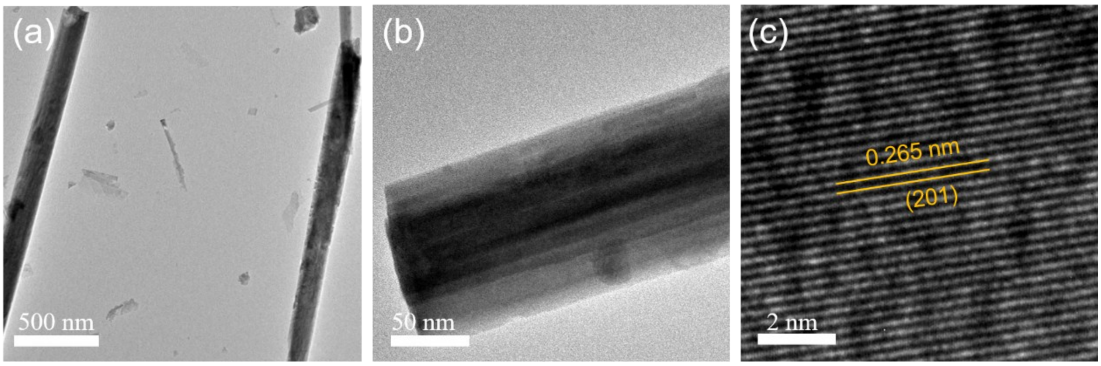

Figure S3. TEM images of Co(OH)F at different magnification.

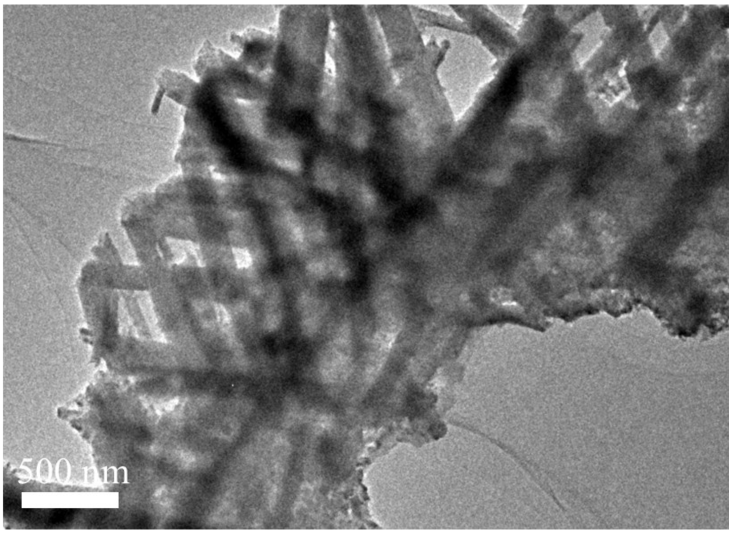

Figure S4. TEM image of Co-P/NF.

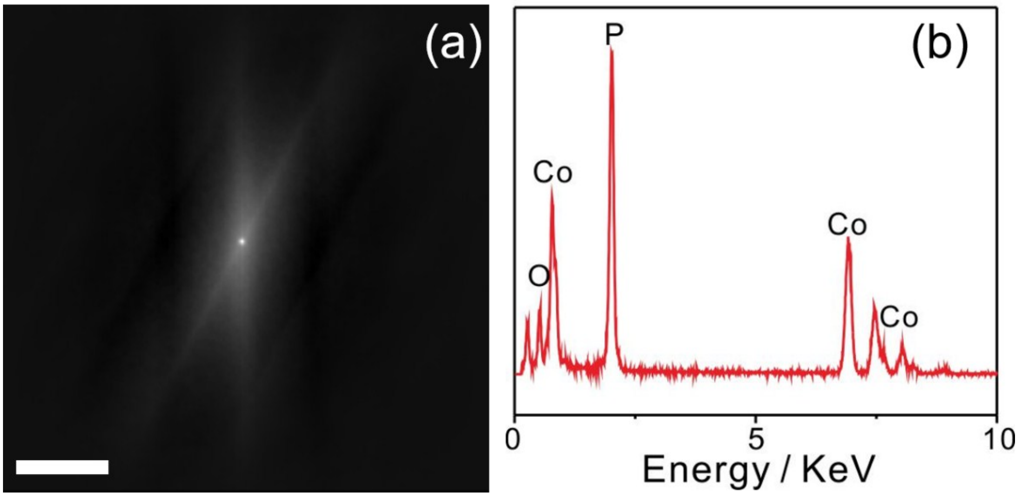

Figure S5. (a) SAED pattern of the prepared Co-P/NF. (b) EDX spectrum of the prepared Co-P/NF.

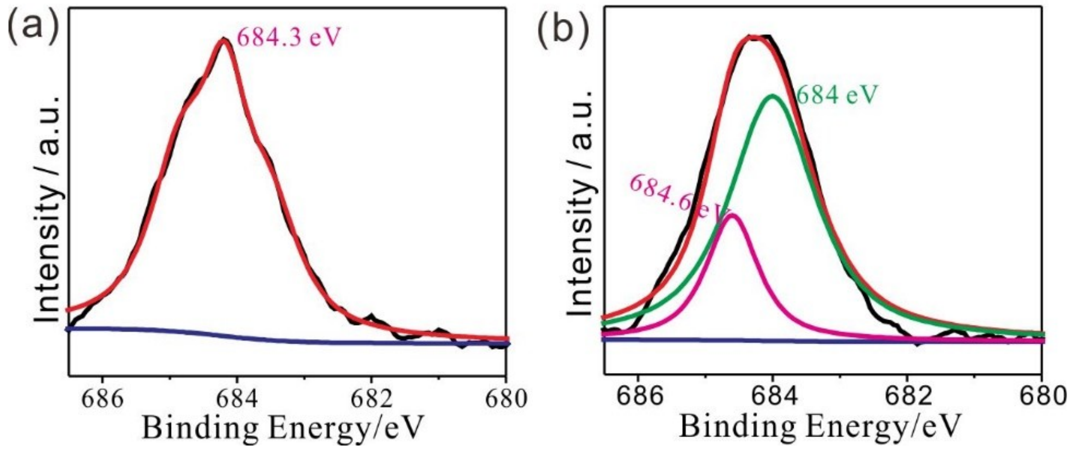

Figure S6. High-resolution XPS spectrum of F 1s before (a) and after (b) UOR-HER test.

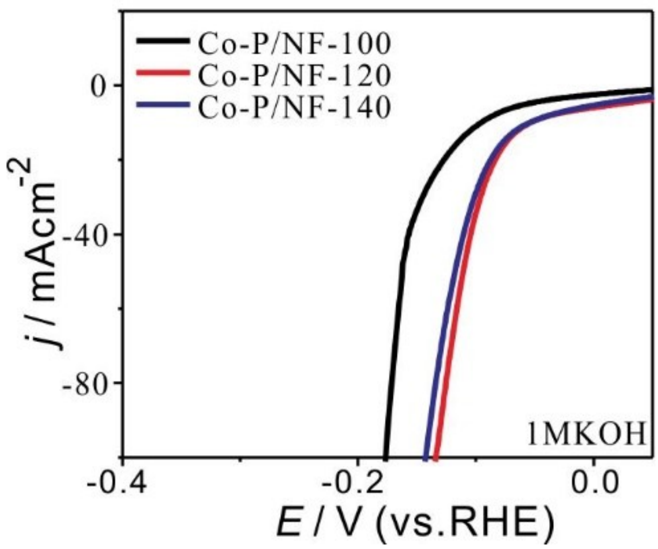

Figure S7. LSVs of Co-P/NF prepared at different solvothermal temperatures.

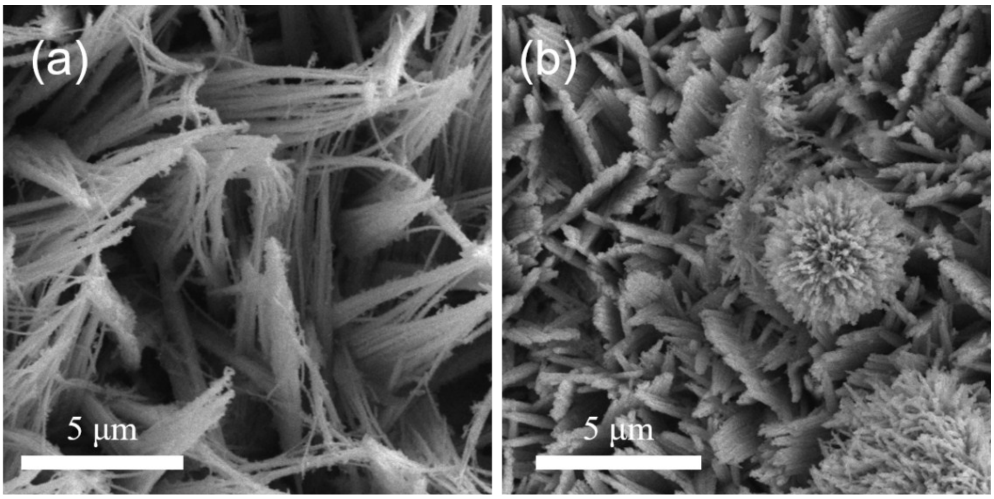

Figure S8. SEM images of solvothermal products at 100 ^{o}C (a) and 140 ^{o}C (b).

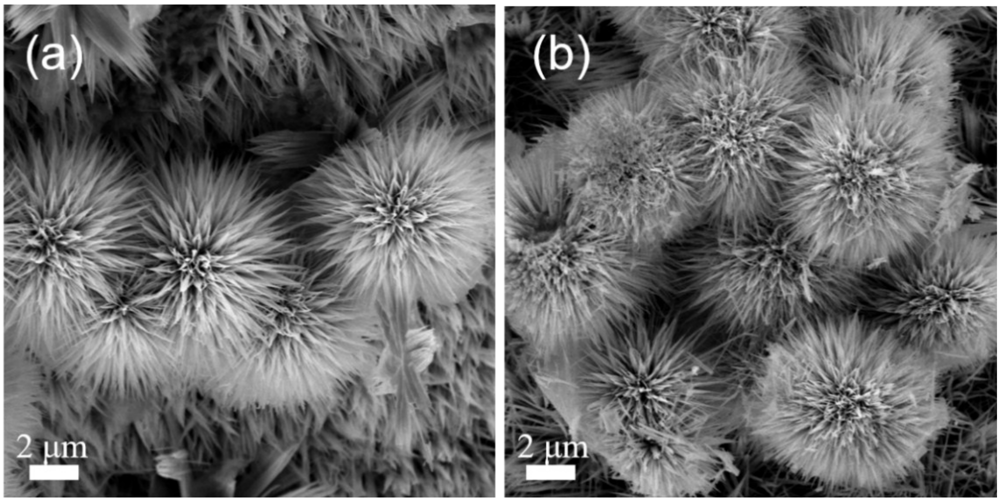

Figure S9. SEM images of Co-P/NF with different molar ratio of P: Co (a, 3:1), (b, 8:1).

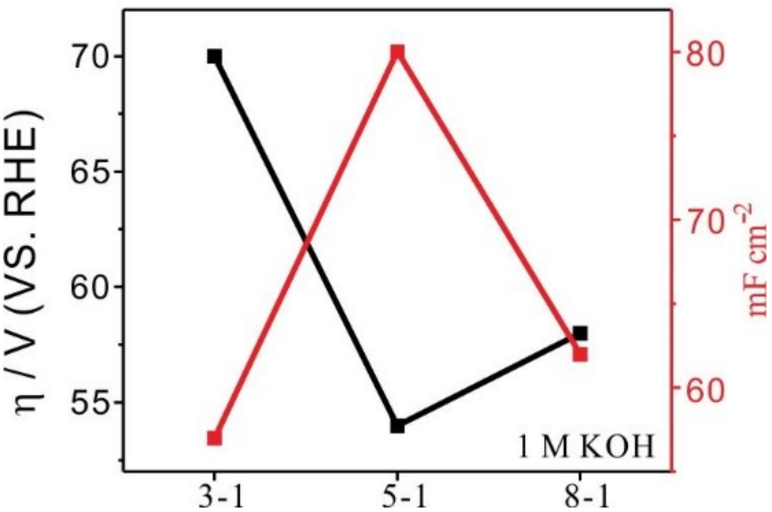

Figure S10. Overpotentials and EDLC values of the prepared catalysts.

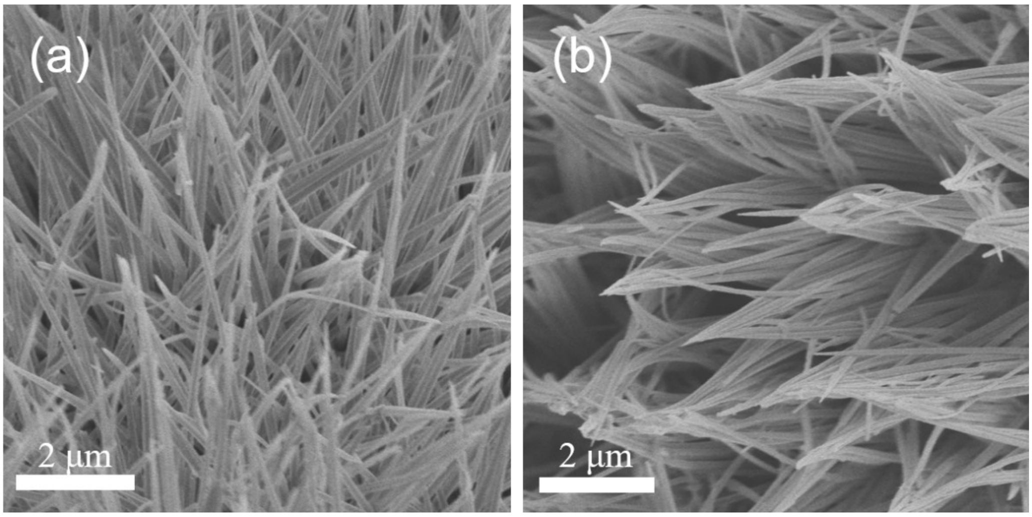

Figure S11. SEM images after water splitting in UOR (a) and HER (b) electrodes.

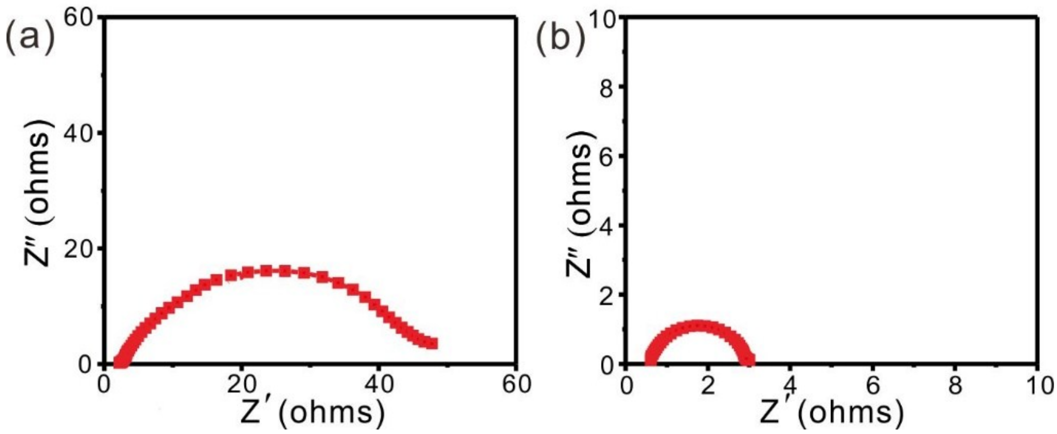

Figure S12. Nyquist plots of Co(OH)F/NF (a) and Co-P/NF (b).

Table S1. Comparison of the HER performance for Co-P/NF in 1 M KOH.

Samples	**η/mV@10 mA cm^{-2}**	**References**
Co-P/NF	43	This Work
$Ni_{0.89}Co_{0.11}Se_2$ MNSN/NF	52	Adv. Mater. **2017**, 29, 1606521
HP-$NiSe_2$	57	Energy Environ. Sci., **2017**, 10, 1487-1492
Mo–Ni_2P NWs/NF	67	Nanoscale, **2017**, 9, 16674–16679
$NiSe_2$/Ni	143	Nano Energy **2016**, 20, 29–36
1T-MoS_2/G/NF	117	J. Mater. Chem. A **2018**, 6, 16458–16464
Mn−Co−P/Ti	49	ACS Catal. **2017**, 7, 98−102
MoP_2 NPs/Mo	143	Nanoscale, **2016**, 8, 8500-8504
FLNPC@MoP-NC/MoP-C/CC	74	Adv. Funct. Mater. **2018**, 28, 1801527
CoP_2/CC-4	56	J. Mater. Chem. A **2018**, 6, 19038-19046
MoP NA/CC	124	Appl. Catal. B: Environ. **2016**, 196, 193–198
ANF@NW	145	Small **2018**, 14, 1800294
Co-Fe-P	66	Nano Energy **2019**, 56, 225-233.
Ni-CoP/HPFs	144	Nano Energy **2019**, 56, 411–419
$(CuPd)_{17}Se_{15}$	188.5	ACS Energy Lett. **2018**, 3, 3008−3014
CC@N-CoP	42	Adv. Mater. **2018**, 1800140
CoP/NiCoP/NC	60	Adv. Funct. Mater. **2018**, 1807976
h-MoN@BNCNT	78	Adv. Funct. Mater. **2018**, 1805893

Table S2. Comparison of the HER performance for Co-P/NF in 1 M KOH.

Samples	**η/mV@10 mA cm^{-2}**	**References**
Co-P/NF	70	This Work
$Ni_{0.89}Co_{0.11}Se_2$ MNSN/NF	85	Adv. Mater. **2017**, 29, 1606521
Co_3O_4@Ni	225	J. Power Sources **2017**, 341, 250-256
$MoS_2/Ni_3S_2/Ni$	76	ACS Appl. Mater. Interfaces **2018**, 10, 1752−1760
Mo–Ni_2P NWs/NF	78	Nanoscale, **2017**, 9, 16674–16679
$NiCo_2S_4$ NW/NF	210	Adv. Funct. Mater. **2016**, 26, 4661–4672
NiFe/$NiCo_2O_4$/NF	105	Adv. Funct. Mater. **2016**, 26, 3515–3523
$NiCo_2S_4$ /Ni_3S_2 /NF	119	ACS Appl. Mater. Interfaces, **2018**, 10, 10890−10897
Co–Ni–Se/C/NF	90	J. Mater. Chem. A, **2016**, 4, 15148-15155
R-MoS_2@NF	104	Adv. Mater. **2018**, 30, 1707105
Am $FePO_4$/NF	123	Adv. Mater. **2017**, 29, 1704574
NiCoFe phosphate NSs-C/NF	231	Nanoscale, **2018**, 10, 12975-12980
$Co(OH)_2$@NCNTs@NF	170	Nano Energy **2018**, 47, 96–104
MoP/NF	114	Small Methods **2018**, 2, 1700369
CoNi/$CoFe_2O_4$/NF	82	J. Mater. Chem. A, **2018**, 6, 19221-19230
CoP/NiCoP/NC	75	Adv. Funct. Mater. **2018**, 1807976
Ni-FeP/TiN/CC	75	Nano Energy **2018**, 53, 66–73
Ni-CoP/HPFs	92	Nano Energy **2019**, 56, 411–419
Co-Fe-P	66	Nano Energy **2019**, 56, 225-233.
S:Co_2P@NF	105	Chem. Mater. **2018**, 30, 8861−8870
$(Co_{1-x}Ni_x)$ $(S_{1-y}P_y)_2$/G	117	Adv. Energy. Mater. **2018**, 1802319
NiFe LDH@NiCoP/NF	120	Adv. Funct. Mater. **2018**, 28, 1706847
Cu NDs/Ni_3S_2 NTs-CFs	128	J. Am. Chem. Soc. **2018**, 140, 610-617
Mc-Mo-850	119	Adv. Funct. Mater. **2018**, 1807419
$CoSe_2$	103	Nat. Commun. **2018**, 9, 2533
CoP@NPMG	151	Nanoscale **2018**, 10, 2603-2612

h-MoN@BNCNT	118	Adv. Funct. Mater. **2018**, 1805893
CoP-A	100	Chem. Sci. **2018**, DOI: 10.1039/C8SC04589E
NiCoFeP	131	Small **2018**, 1802442
NiCoFeB	345	Small **2018**, 1804212

Table S3. Comparison of the OER performance for Co(OH)F/NF in 1 M KOH.

Samples	**η/mV@10 mA cm^{-2}**	**References**
Co(OH)F/NF	270	This Work.
Cu_3P@NF	330	ACS Appl. Mater. Interfaces **2017**, 9, 2240–2248
$Ni_xCo_{2x}(OH)_{6x}$@eRG	280	Chem. Engineer. J. **2017**, 327, 9–17
$Fe_{2-x}Mn_xP$	440	Chem. Mater. **2017**, 29, 3048−3054
Co−Cu_7S_4-0.07	270	ACS Nano **2017**, 11, 12230−12239
$Na_{0.08}Ni_{0.9}Fe_{0.1}O_2$	260	Energy Environ. Sci., **2017**, 10, 121-128
$CoO_{0.87}S_{0.13}$/GN	357	Adv. Mater. **2017**, 29, 1702526
Co@Co–Bi/Ti	327	Nanoscale, **2017**, 9, 16059-16065
NiSe/CFs	286	Carbon **2018**, 129, 245-251
Co-UNMs	307	ACS Catal. **2018**, 8, 1913-1920
NiCoP@Cu_3P/CF	309	J. Mater. Chem. A, **2018**, 6, 2100-2106
$Co(OH)_2$@NCNTs@NF	270	Nano Energy **2018**, 47, 96-104
Mo-CoOOH	305	Nano Energy **2018**, 48, 73–80
NiCoFeB	284	Small **2018**, 1804212
Ni_3N-NiMoN	277	Nano Energy **2018**, 44, 353–363
Co0.30CuOx NF	290	ACS Catal. **2018**, 8, 12030−12040
CSLB	362.5	Nano Energy **2019,** 57, 371-378
NiCoFeP	273	Small **2018**, 1802442
$(Co_{1-x}Ni_x)(S_{1-y}P_y)_2$/G	285	Adv. Energy. Mater. **2018**, 1802319
TANF	290	Angew. Chem. Int. Ed. **2018** DOI: 10.1002/anie.201811241

Table S4. Comparison of Co-P/NF || Co(OH)F/NF with reported catalysts for urea assisted water splitting.

Samples	**η / mV@ j (mA cm^{-2})**	**References**
Co-P/NF || Co(OH)F/NF	1.42@20	This Work
Ni_2P	1.35 V@50	*J. Mater. Chem. A* **2017**, 5, 3208.
$Ni(OH)_2$	1.344 V@1	*Angew. Chem. Int. Ed.* **2016**, 55, 12465.
Ni-MOF	1.36 V@10	*Chem. Commun.* **2017**, 53, 10906.
MnO_2	1.41 V@10	*Angew. Chem. Int. Ed.* **2016**, 55, 3804.
$NiMn_2O_4$	1.29 V@6.9	*ACS Appl. Mater. Interfaces* **2016**, 8, 12176.
NiMoS	1.59@10	*Nano Res.* **2018**, 11, 988.
Fe-Ni_3S_2	1.46@10	*J. Mater. Chem. A,* **2018**, 6, 4346.
$NiMoO_4$	1.38 @10	*Energy Environ. Sci.,* **2018**, 11, 1890.