Electronic Supplementary Material (ESI) for Chemical Society Reviews.
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Electronic Supplementary Information (ESI) of "Hydrovoltaic Technology: from Mechanism to Applications"

Various hydrovoltaic devices can harvest mechanical energy and latent heat from the earth water cycle, including bulk-water waving and flowing, droplets dragging and impinging, water evaporation and moisture absorption. And for different water form, there are also differences in material system, device structure and power generation capacity, and we here summarize the main achievements in Table S1. Note that careful evaluations of chemical interactions should be taken into account when metal alligator clips were employed in their experiments.

Table S1 Overview of water-energy harvestings and performance comparisons

Water form	Materials	V_{oc}	I_{sc}	Solution	Electrode	Marks	Reference
Bulk water motion	CVD Gr/PET	0.1 V	~11 μA	NaCl	Ag emulsion	Waving potential	Ref S1
	CVD Gr/PET pair	~1 V	~2 μA	NaCl	Ag emulsion	One Gr pair fixed	Ref S2
	Gr-CB/PU	0.02 V	~10 μA	NaCl	Cu	Ocean wave energy	Ref S3
	ZnO nanofilms/PET	~0.05 V	1.3 μA	NaCl	Ag emulsion	--	Ref S4
	Metal oxide nanolayers	millivolt	~0.2 μA	NaCl	--	Heterogeneous salinity	Ref S5
	MoS_2-encapsulated C fibers	0.54 V	~2 mA	NaCl	Cu wire	DC	Ref S6
	PTFE tube	~904 V	509 μA	Rain water	Al and Cu	Volume effect	Ref S7
Water droplet	Gr/PET	<1 mV	< 1 μA	NaCl	Ag emulsion	Drawing potential	Ref S8
	Gr/PVDF	~0.5 V	~25 μA	NaCl	Silver epoxy	Pre-polarized PVDF	Ref S9
	MoS_2/PEN	~5 V	~5 nA	NaCl	Silver paste	--	Ref S10
	Silicon	~0.3 V	0.64 μA	Water	Ti/Au	Droplet between PN junction	Ref S11
	Silicon/Gr	~0.3 V	~0.7 μA	Water	Ti/Au	Droplet between PN junction	Ref S12
	Silica/PV4P/Cu_xO	~0.03 V	~6.4 nA.	NaCl	--	Electrolyte-insulator-	Ref S13

						semiconductor	
	Silica gel+APTES+ POTS	~1 V	~0.55 μA	NaCl	ITO	Surface functionality control	Ref S14
	CYTOP and PTFE	~42 V	--	Water	Silicon	Planar structure, alternate contacts	Ref S15
	PTFE	~4 V	~0.5μA	Water	ITO	Press-releasing mode	Ref S16
	PTFE	~150 V	~250 μA	Tap water	Al/ITO	Transient pulse	Ref S17
	FEP	~200 V	~400 μA	Tap water	Al/Cu	Superhydrophobic	Ref S18
Water evaporation	Carbon black	~1 V	~150 nA	DI water	MWCNTs	DC output for 8 days	Ref S19
	All-printed CB slurry	~0.5 V	~300 nA	DI water	MWCNTs	Additives of terpineol, ethyl cellulose and ethanol	Ref S20
	Cotton fabric/CB	0.53 V	3.91 μA	Salt solutions	Alligator clips	KCl, NaCl, LiCl, HCl	Ref S21
	Carbon black	0.79 V	~120 nA	DI water	CNTs	Al_2O_3 substrate	Ref S22
	3D G membrane	~0.28 V	~10 μA	NaCl	Cu	Cu/3DG/Cu, vertical	Ref S23
	Porous GO sponges	0.63 V	27.4 μA	DI water	SACNT bucky papers	Partially-reduced	Ref S24
	rGO film	~1 V	~10 μA	NaCl	CNTs	Honeycomb structured	Ref S25
	Metal oxides film	~2.5 V	0.18 μA	DI water	Carbon paste	PET substrate	Ref S26
	Ni-Al LDH film	~0.7 V	~1.3 μA	DI water	CNTs	PET substrate	Ref S27
	Porous ZnO film	~0.4 V	~20 nA	DI water	Ag/AgCl	--	Ref S28
	CuO nanowire film	~0.45 V	0.23 μA	NaCl	Alligator clips	Droplet Infiltrations	Ref S29
	TiO_2 nanoparticle film	~0.2 V	~120 nA	DI water	MWCNTs	Atmosphere monitoring	Ref S30
	AlOOH/UIO-66 MOF	1.63 V	~500 nA	DI water	Silver slurry	--	Ref S31
	CBAP/PVDF	~0.2 V	~500 nA	NaCl	Pt	Solar steam desalination	Ref S32
	paper-based CuCAT-1 MOF	~0.55 V	~30 μA	NaCl	Alligator clips	Cogenerating freshwater	Ref S33
	Cu(BDC-OH) MOF	~0.6 V	~120 nA	DI Water	CB/Cu paste	Hierarchical Oriented	Ref S34
	PEDOT:PSS/GO sponge	2.13 V	~8 $\mu A/cm^2$	DI water	Cu	Thermoelectric	Ref S35
	Wasted tree gum	~0.4 V	~3 μA	DI water	--	Carbonization	Ref S36
	Carbon nanoparticles/ TiO_2 nanowires	~1.3 V	~350 nA	DI water	Carbon ink	Photo-response performance	Ref S37
	Gr /α-FeOOH film	~0.4 V	~3 μA	NaCl	CNTs	H_2O_2 boosting	Ref S38
	MoS_2/SiO_2 film	~0.8 V	0.25 μA	NaCl	Pt	--	Ref S39
	3D wood	0.3 V	10 μA	DI water	Carbon paste	Natural directional channels	Ref S40

	Cellulose fabrics	~0.7 V	~3 μA	NaCl	Cu	--	Ref S41
	Silicon nanowire arrays	0.4 V	55 μA/cm^2	DI water	Graphite and Ag paint	Directional nanochannels	Ref S42
	Silicon nanowire arrays	0.55 V	22 μA/cm^2	DI water	Hierarchical Nanofabric	Graphite/PEDOT:PSS/fabric and silver paint	Ref S43
	Carbon black-glass fiber hybrid film	~5.0 V	~1.5 μA	DI water	CNT ink	Two films with opposite surface charges	Ref S44
	PVA/FCB/3DS film	0.7 V	~63 μA	Hydrogel	Cu	PVA skeleton	Ref S45
	d-Al_2O_3/gelatin	6.4 V	~0.7 μA	DI water	Conductive carbon paste	Combination with thermoelectric	Ref S46
	Carbon slurry	1.2 V	~0.5 μA	DI water	CNT ink	--	Ref S47
	Ethanol carbon black	~1.0 V	~100 nA	DI water	Ag	Memristor	Ref S48
	Toluene carbon black	~1.2 V	475 nA	DI water	CNTs	Gas monitor	Ref S49
(Solar enhancement)	CNTs/cellulose paper	0.47-0.6 V	5-22 μA	Water	Ni/Cu	Solar-energy enhancement	Ref S50
	CB/PVA+wood	~1.2 V	~4.5 μA	Water	Ag	Asymmetric evaporation	Ref S51
	Ti_3C_2TX film	~40 mV	~12 μA	DI water	Ag	Asymmetric irradiation	Ref S52
	CNT film	~0.48 V	~40 mA/g	Water	CNTs	Asymmetric irradiation	Ref S53
Moisture	3-layers g-GO film	~20 mV	~5 μA/cm^2	$\Delta_{RH=30\%}$	Au	Breath sensor	Ref S54
	3D g-GO framework	0.26 V	3.2 mA/cm^2	$\Delta_{RH=75\%}$	Al	--	Ref S55
	Graphene quantum dots	0.15 V	~16.8 mA/cm^2	$\Delta_{RH=50\%}$	Au	High specific surface area	Ref S56
	GO/Paper (r=1mm)	~0.7 V	~38 μA/cm^2	$\Delta_{RH=60\%}$	Ag paste	Printable, flexible	Ref S57
	Pristine Graphene-Oxide	~0.4 V	~1.5 μA/cm^2	$\Delta_{RH=70\%}$	Au	--	Ref S58
	Flexible GO film	~0.2 V	~1.2 μA	$\Delta_{RH=80\%}$	rGO	Direct laser reduction	Ref S59
	g-rGO/GO	1.5 V	~43.3 nA/cm^2	$\Delta_{RH=80\%}$	Au	Schottky junction	Ref S60
	In-plane graphene oxide	70 mV	12 mA/cm^2	$\Delta_{RH=60\%}$	rGO	Direct laser reduction	Ref S61

	GO fiber	0.35 V	1.06 mA cm^{-2}	$\Delta_{RH=65\%}$	rGO	Laser-reduced GO as electrodes	Ref S62
	3D polypyrrole (PPy) framework	60 mV	~12 μA/cm^2	$\Delta_{RH=85\%}$	Au	Anion gradients	Ref S63
	Polypyrrole (PPy) nanowire array	~80 mV	~150 nA	$\Delta_{RH=80\%}$	Au	Sodium ion gradient doped	Ref S64
	1D polypyrrole nanoarray	~0.15 V	~500 nA	$\Delta_{RH=75\%}$	Au	High-valent metal carrier transport	Ref S65
	PSSA membrane	~0.8 V	0.1 mA/cm^2	$\Delta_{RH=80\%}$	Au	Various polymers, flexible	Ref S66
	PSS/PVA film	~0.6 V	13.2 μA/cm^2	$\Delta_{RH=85\%}$	Ag NWs	Transparent, self-healing, arbitrary tailorable	Ref S67
	Porous polydopamine layer	0.52 V	3.1 mA/cm^2	$\Delta_{RH=90\%}$	Ag	Pulse/DC, Wearable sensor	Ref S68
	Thin gelatin film	0.71 V	~7.7 μA/cm^2	$\Delta_{RH=90\%}$	Cu/Al	Cu/protein/Al	Ref S69
	Print paper	0.25 V	~10 nA/cm^2	$\Delta_{RH=70\%}$	ITO/Au	Asymmetry electrode	Ref S70
	TiO_2 nanowire networks	~0.6 V	~9 μA/cm^2	$\Delta_{RH=85\%}$	Al	Breathing sensor	Ref S71
	Bulk rGO	~0.45 V	4.48 μA/cm^2	RH=85%	Au	DC, flexible integration	Ref S72
	GO/PAAS	~0.6 V	> 1μA/cm^2	RH=85%	Au/Ag	DC, > 160h	Ref S73
	PSSA/PDDA	1.38 V	~4 μA/cm^2	RH=85%	Carbon tape	DC, heterogenous structure	Ref S74
	Toluene CB	~65 mV	0.6 nA/cm^2	RH>95%	Cu	DC, Asymmetric functionalization	Ref S75
	Carbon-coated cotton fiber	0.74 V	0.83 μA/cm^2	RH=37%	Alligator clips	DC, $CaCl_2$ modification	Ref S76

	Waste corn stalk	~0.25 V	~0.5 μA/cm^2	RH=75%	Cu	DC, KCl modification	Ref S77
	Cellulose acetate membranes	0.32 V	~80 nA/cm^2	RH~80%	Ag gauze	DC or pulse, electrostatic spinning	Ref S78
	Biological nanofibrous	0.1 V	~30 nA/cm^2	RH=99%	Pt nets	DC or pulse, Cellulose, chitin, silk fibroin, and amyloid	Ref S79
	Protein wires	~0.5 V	17 μA/cm^2	RH~50%	Au	DC, > 2month, a spontaneous water gradient	Ref S80

Reference

S1. J. Yin, Z. Zhang, X. Li, J. Yu, J. Zhou, Y. Chen and W. Guo, *Nature Communications*, 2014, **5**, 1-6.

S2. W. Fei, C. Shen, S. Zhang, H. Chen, L. Li and W. Guo, *Nano Energy*, 2019, **60**, 656-660.

S3. J. Tan, J. Duan, Y. Zhao, B. He and Q. Tang, *Nano Energy*, 2018, **48**, 128-133.

S4. X. Li, C. Shen, Q. Wang, C. M. Luk, B. Li, J. Yin, S. P. Lau and W. Guo, *Nano Energy*, 2017, **32**, 125-129.

S5. M. D. Boamah, E. H. Lozier, J. Kim, P. E. Ohno, C. E. Walker, T. F. Miller, 3rd and F. M. Geiger, *Proc Natl Acad Sci U S A*, 2019, **116**, 16210-16215.

S6. J. Yang, C. Yang, J. Cheng, A. Dai, T. Liu, Y. Yuan, K. Guo, D. Yuan, B. Wang and J. Lu, *Cell Reports Physical Science*, 2020, **1**, 100175.

S7. N. Zhang, H. Gu, H. Zheng, S. Ye, L. Kang, C. Huang, K. Lu, W. Xu, Q. Miao, Z. Wang, J. Zhang and X. Zhou, *Nano Energy*, 2020, **73**, 104748.

S8. J. Yin, X. Li, J. Yu, Z. Zhang, J. Zhou and W. Guo, *Nat Nanotechnol*, 2014, **9**, 378-383.

S9. S. Yang, Y. Su, Y. Xu, Q. Wu, Y. Zhang, M. B. Raschke, M. Ren, Y. Chen, J. Wang, W. Guo, Y. Ron Shen and C. Tian, *J Am Chem Soc*, 2018, **140**, 13746-13752.

S10. A. S. Aji, R. Nishi, H. Ago and Y. Ohno, *Nano Energy*, 2020, **68**, 104370.

S11. Y. Lu, Y. Yan, X. Yu, X. Zhou, S. Feng, C. Xu, H. Zheng, Z. Yang, L. Li, K. Liu and S. Lin, *Research (Wash D C)*, 2021, **2021**, 7505638.

S12. Y. Yan, X. Zhou, S. Feng, Y. Lu, J. Qian, P. Zhang, X. Yu, Y. Zheng, F. Wang, K. Liu and S. Lin, *The Journal of Physical Chemistry C*, 2021, **125**, 14180-14187.

S13. H. Jin, S. G. Yoon, W. H. Lee, Y. H. Cho, J. Park and Y. S. Kim, *ACS Applied Energy Materials*, 2019, **3**, 1253-1259.

S14. Y. Yang, J. Park, S. G. Yoon and Y. S. Kim, *Nano Energy*, 2017, **40**, 447-453.

S15. J. Yu, E. Ma and T. Ma, *Sci Rep*, 2017, **7**, 17145.

S16. J. K. Moon, J. Jeong, D. Lee and H. K. Pak, *Nat Commun*, 2013, **4**, 1487.

S17. W. Xu, H. Zheng, Y. Liu, X. Zhou, C. Zhang, Y. Song, X. Deng, M. Leung, Z. Yang, R. X. Xu, Z. L. Wang, X. C. Zeng and Z. Wang, *Nature*, 2020, **578**, 392-396.

S18. L. Wang, Y. Song, W. Xu, W. Li, Y. Jin, S. Gao, S. Yang, C. Wu, S. Wang and Z. Wang, *EcoMat*, 2021, DOI: 10.1002/eom2.12116.

S19. G. Xue, Y. Xu, T. Ding, J. Li, J. Yin, W. Fei, Y. Cao, J. Yu, L. Yuan, L. Gong, J. Chen, S. Deng, J.

Zhou and W. Guo, *Nat Nanotechnol*, 2017, **12**, 317-321.

S20. T. Ding, K. Liu, J. Li, G. Xue, Q. Chen, L. Huang, B. Hu and J. Zhou, *Advanced Functional Materials*, 2017, **27**, 1700551.

S21. T. G. Yun, J. Bae, A. Rothschild and I. D. Kim, *ACS Nano*, 2019, **13**, 12703-12709.

S22. G. Zhang, Y. Xu, Z. Duan, W. Yu, C. Liu and W. Yao, *Applied Thermal Engineering*, 2020, **166**, 114623.

S23. C. Li, Z. Tian, L. Liang, S. Yin and P. K. Shen, *ACS Applied Materials & Interfaces*, 2019, **11**, 4922-4929.

S24. G. Zhang, Z. Duan, X. Qi, Y. Xu, L. Li, W. Ma, H. Zhang, C. Liu and W. Yao, *Carbon*, 2019, **148**, 1-8.

S25. M. Wu, M. Peng, Z. Liang, Y. Liu, B. Zhao, D. Li, Y. Wang, J. Zhang, Y. Sun and L. Jiang, *ACS Appl Mater Interfaces*, 2021, **13**, 26989-26997.

S26. C. Shao, B. Ji, T. Xu, J. Gao, X. Gao, Y. Xiao, Y. Zhao, N. Chen, L. Jiang and L. Qu, *ACS Appl Mater Interfaces*, 2019, **11**, 30927-30935.

S27. J. Sun, P. Li, J. Qu, X. Lu, Y. Xie, F. Gao, Y. Li, M. Gang, Q. Feng, H. Liang, X. Xia, C. Li, S. Xu and J. Bian, *Nano Energy*, 2019, **57**, 269-278.

S28. S. G. Yoon, Y. Yang, J. Yoo, H. Jin, W. H. Lee, J. Park and Y. S. Kim, *ACS Applied Electronic Materials*, 2019, **1**, 1746-1751.

S29. H. Jin, S. G. Yoon, W. H. Lee, Y. H. Cho, J. Han, J. Park and Y. S. Kim, *Energy & Environmental Science*, 2020, **13**, 3432-3438.

S30. T. Zhong, H. Li, T. Zhao, H. Guan, L. Xing and X. Xue, *Journal of Materials Science & Technology*, 2021, **76**, 33-40.

S31. Q. Ma, Q. He, P. Yin, H. Cheng, X. Cui, Q. Yun and H. Zhang, *Adv Mater*, 2020, **32**, e2003720.

S32. Z. Li, X. Ma, D. Chen, X. Wan, X. Wang, Z. Fang and X. Peng, *Adv Sci (Weinh)*, 2021, **8**, 2004552.

S33. X. Ma, Z. Li, Z. Deng, D. Chen, X. Wang, X. Wan, Z. Fang and X. Peng, *Journal of Materials Chemistry A*, 2021, **9**, 9048-9055.

S34. Z. Wang, Y. Wu, K. Xu, L. Jiang, J. Sun, G. Cai, G. Li, B. Y. Xia and H. Liu, *Advanced Functional Materials*, 2021, DOI: 10.1002/adfm.202104732, 2104732.

S35. X. Qi, T. Miao, C. Chi, G. Zhang, C. Zhang, Y. Du, M. An, W.-G. Ma and X. Zhang, *Nano Energy*, 2020, **77**, 105096.

S36. A. Venkateshaiah, J. Y. Cheong, S.-H. Shin, K. P. Akshaykumar, T. G. Yun, J. Bae, S. Wacławek, M. Černík, S. Agarwal, A. Greiner, V. V. T. Padil, I.-D. Kim and R. S. Varma, *Green Chemistry*, 2020, **22**, 1198-1208.

S37. B. Ji, N. Chen, C. Shao, Q. Liu, J. Gao, T. Xu, H. Cheng and L. Qu, *Journal of Materials Chemistry A*, 2019, **7**, 6766-6772.

S38. W. Wang, W. Gong, Y. Wang, G. Li, W. Lu, Y. You and X. Zhang, *Journal of Materials Chemistry A*, 2021, **9**, 5588-5596.

S39. S. G. Yoon, H. Jin, W. H. Lee, J. Han, Y. H. Cho and Y. S. Kim, *Nano Energy*, 2021, **80**, 105522.

S40. X. Zhou, W. Zhang, C. Zhang, Y. Tan, J. Guo, Z. Sun and X. Deng, *ACS Appl Mater Interfaces*, 2020, **12**, 11232-11239.

S41. S. S. Das, V. M. Pedireddi, A. Bandopadhyay, P. Saha and S. Chakraborty, *Nano Lett*, 2019, **19**, 7191-7200.

S42. Y. Qin, Y. Wang, X. Sun, Y. Li, H. Xu, Y. Tan, Y. Li, T. Song and B. Sun, *Angew Chem Int Ed Engl*, 2020, **59**, 10619-10625.

S43. B. Shao, Z. Song, X. Chen, Y. Wu, Y. Li, C. Song, F. Yang, T. Song, Y. Wang, S. T. Lee and B. Sun, *ACS Nano*, 2021, **15**, 7472-7481.
S44. J. Li, K. Liu, T. Ding, P. Yang, J. Duan and J. Zhou, *Nano Energy*, 2019, **58**, 797-802.
S45. L. Li, M. Hao, X. Yang, F. Sun, Y. Bai, H. Ding, S. Wang and T. Zhang, *Nano Energy*, 2020, **72**, 104663.
S46. L. Li, S. Feng, Y. Bai, X. Yang, M. Liu, M. Hao, S. Wang, Y. Wu, F. Sun, Z. Liu and T. Zhang, *Nat Commun*, 2022, **13**, 1043.
S47. H. He, T. Zhao, H. Guan, T. Zhong, H. Zeng, L. Xing, Y. Zhang and X. Xue, *Science Bulletin*, 2019, **64**, 1409-1417.
S48. G. Zhou, Z. Ren, L. Wang, J. Wu, B. Sun, A. Zhou, G. Zhang, S. Zheng, S. Duan and Q. Song, *Nano Energy*, 2019, **63**, 103793.
S49. T. Zhong, H. Guan, Y. Dai, H. He, L. Xing, Y. Zhang and X. Xue, *Nano Energy*, 2019, **60**, 52-60.
S50. P. Xiao, J. He, F. Ni, C. Zhang, Y. Liang, W. Zhou, J. Gu, J. Xia, S.-W. Kuo and T. Chen, *Nano Energy*, 2020, **68**, 104385.
S51. J. Liu, J. Gui, W. Zhou, X. Tian, Z. Liu, J. Wang, J. Liu, L. Yang, P. Zhang, W. Huang, J. Tu and Y. Cao, *Nano Energy*, 2021, **86**, 106112.
S52. J. Lao, S. Wu, J. Gao, A. Dong, G. Li and J. Luo, *Nano Energy*, 2020, **70**, 104481.
S53. Y. Hu, S. He, X. Xu, L. Zhang, Y. Xu, J. Zhang, P. Liu, Y. Wen, F. Ni, M. Jia, B. Zhang, X. Sun, P. Chen and H. Peng, *Journal of Materials Chemistry A*, 2019, **7**, 1996-2001.
S54. F. Zhao, H. Cheng, Z. Zhang, L. Jiang and L. Qu, *Adv Mater*, 2015, **27**, 4351-4357.
S55. F. Zhao, Y. Liang, H. Cheng, L. Jiang and L. Qu, *Energy & Environmental Science*, 2016, **9**, 912-916.
S56. Y. Huang, H. Cheng, G. Shi and L. Qu, *ACS Appl Mater Interfaces*, 2017, **9**, 38170-38175.
S57. Y. Liang, F. Zhao, Z. Cheng, Y. Deng, Y. Xiao, H. Cheng, P. Zhang, Y. Huang, H. Shao and L. Qu, *Energy & Environmental Science*, 2018, **11**, 1730-1735.
S58. T. Xu, X. Ding, C. Shao, L. Song, T. Lin, X. Gao, J. Xue, Z. Zhang and L. Qu, *Small*, 2018, **14**, e1704473.
S59. C. Yang, Y. Huang, H. Cheng, L. Jiang and L. Qu, *Adv Mater*, 2019, **31**, e1805705.
S60. Y. Huang, H. Cheng, C. Yang, P. Zhang, Q. Liao, H. Yao, G. Shi and L. Qu, *Nat Commun*, 2018, **9**, 4166.
S61. H. Cheng, Y. Huang, L. Qu, Q. Cheng, G. Shi and L. Jiang, *Nano Energy*, 2018, **45**, 37-43.
S62. Y. Liang, F. Zhao, Z. Cheng, Q. Zhou, H. Shao, L. Jiang and L. Qu, *Nano Energy*, 2017, **32**, 329-335.
S63. J. Xue, F. Zhao, C. Hu, Y. Zhao, H. Luo, L. Dai and L. Qu, *Advanced Functional Materials*, 2016, **26**, 8784-8792.
S64. X. Nie, B. Ji, N. Chen, Y. Liang, Q. Han and L. Qu, *Nano Energy*, 2018, **46**, 297-304.
S65. N. Chen, Q. Liu, C. Liu, G. Zhang, J. Jing, C. Shao, Y. Han and L. Qu, *Nano Energy*, 2019, **65**, 104047.
S66. T. Xu, X. Ding, Y. Huang, C. Shao, L. Song, X. Gao, Z. Zhang and L. Qu, *Energy & Environmental Science*, 2019, **12**, 972-978.
S67. H. Wang, H. Cheng, Y. Huang, C. Yang, D. Wang, C. Li and L. Qu, *Nano Energy*, 2020, **67**.
S68. L. Li, Z. Chen, M. Hao, S. Wang, F. Sun, Z. Zhao and T. Zhang, *Nano Lett*, 2019, **19**, 5544-5552.
S69. S. Mandal, S. Roy, A. Mandal, T. Ghoshal, G. Das, A. Singh and D. K. Goswami, *ACS Applied Electronic Materials*, 2020, **2**, 780-789.

S70. X. Gao, T. Xu, C. Shao, Y. Han, B. Lu, Z. Zhang and L. Qu, *Journal of Materials Chemistry A*, 2019, **7**, 20574-20578.

S71. D. Shen, M. Xiao, G. Zou, L. Liu, W. W. Duley and Y. N. Zhou, *Adv Mater*, 2018, **30**, e1705925.

S72. H. Cheng, Y. Huang, F. Zhao, C. Yang, P. Zhang, L. Jiang, G. Shi and L. Qu, *Energy & Environmental Science*, 2018, **11**, 2839-2845.

S73. Y. Huang, H. Cheng, C. Yang, H. Yao, C. Li and L. Qu, *Energy & Environmental Science*, 2019, **12**, 1848-1856.

S74. H. Wang, Y. Sun, T. He, Y. Huang, H. Cheng, C. Li, D. Xie, P. Yang, Y. Zhang and L. Qu, *Nat Nanotechnol*, 2021, **16**, 811-819.

S75. K. Liu, P. Yang, S. Li, J. Li, T. Ding, G. Xue, Q. Chen, G. Feng and J. Zhou, *Angew Chem Int Ed Engl*, 2016, **55**, 8003-8007.

S76. J. Bae, T. G. Yun, B. L. Suh, J. Kim and I.-D. Kim, *Energy & Environmental Science*, 2020, **13**, 527-534.

S77. F. Gong, H. Li, Q. Zhou, M. Wang, W. Wang, Y. Lv, R. Xiao and D. V. Papavassiliou, *Nano Energy*, 2020, **74**, 104922.

S78. Q. Lyu, B. Peng, Z. Xie, S. Du, L. Zhang and J. Zhu, *ACS Appl Mater Interfaces*, 2020, **12**, 57373-57381.

S79. M. Li, L. Zong, W. Yang, X. Li, J. You, X. Wu, Z. Li and C. Li, *Advanced Functional Materials*, 2019, **29**, 1901798.

S80. X. Liu, H. Gao, J. E. Ward, X. Liu, B. Yin, T. Fu, J. Chen, D. R. Lovley and J. Yao, *Nature*, 2020, **578**, 550-554.