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Supporting information

Regulation of intrinsic physicochemical properties of metal oxide nanomaterials for energy conversion and environmental detection applications

Li Chen,[a, b] Zhonggang Liu,[a, b] Zheng Guo*[a, b] and Xing-Jiu Huang*[a, b, c, d]

a. Institutes of Physical Science and Information Technology, Anhui University, Hefei, 230601, PR China. E-mail: zhguo@ahu.edu.cn

b. Information Materials and Intelligent Sensing Laboratory of Anhui Province, Institutes of Physical Science and Information Technology, Anhui University, Hefei, Anhui, 230601, P. R. China

c. Institute of Intelligent Machines, Chinese Academy of Sciences, Hefei, 230031, PR China. E-mail: xingjiuhuang@iim.ac.cn

d. Department of Chemistry, University of Science and Technology of China, Hefei, 230026, PR China.

Table S1 Detailed comparison of OER activity for metal oxide nanomaterials with different size

Metal oxide nanomaterials	Size(nm)	BET SA (m^2 / g)	Potential (mV) at 10 mA/cm^2	Tafel slope (mV dec^{-1})	Electrolyte	*Ref.*
Co_3O_4	5.9	111.2	534	-47±7	1M KOH	S1
	21.1	27.93	569			
	46.9	7.80	588			
$Co_3O_{4-\delta}$ quantum dots	2	-	270	38.8	1M KOH	S2
NiO	3.3	210	300 (7.5 mA/cm^2)	40	0.5M KOH	S3

Table S2 The intrinsic physicochemical properties of metal oxide nanomaterials and their corresponding performance for electrocatalytic water splitting

Electrocatalysts	**Size [nm]**	**Reactions**	**Electrolyte**	**overpotential η [mV] at 10 mA cm^{-2}**	**Tafel slope [mV dec^{-1}]**	**Ref.**
Co_3O_4	5.9 21.1 46.9	OER	1.0 M KOH	534 569 588	-47±7	S1
$Co_3O_{4-\delta}$ quantum dots	2	OER	1.0 M KOH	270	38.8	S2
NiO	3.3	OER	0.1 M KOH	300 (7.5 mA/cm^2)	40.0	S3
Electrocatalysts	**Shape**	**Reactions**	**Electrolyte**	**overpotential η [mV] at 10 mA cm^{-2}**	**Tafel slope (mV dec^{-1})**	**Ref.**
MoO_2	nanosheets	HER OER	1.0 M KOH	27 200	41.0 54.0	S4
$NiCo_2O_4$	microcuboids	HER OER	1.0 M NaOH	50 230	49.7 53.0	S5
NiFe-Oxide	nanocubes	HER OER	1.0 M KOH	271 197	48.0 58.0	S6
Co_3O_4	hollow microspheres	OER	0.1 M KOH	~400	-	S7
Co_3O_4	nanoparticle	OER	1.0 M KOH	497	-	S8
Co_3O_4	nanoparticle	OER	1.0 M KOH	314(0.5 mA/cm^2)	-	S9
Co_3O_4	microtube	OER	1.0 M KOH	290	84	S10
Co_3O_4	nano-islands	OER	1.0 M KOH	376	59	S11
Co_3O_4	nanorods	OER	1.0 M KOH	275	-	S12
Co_3O_4	nanowire	OER	0.1 M KOH	290	70	S13
Electrocatalysts	**Defect type**	**Reactions**	**Electrolyte**	**overpotential η [mV] at 10 mA cm^{-2}**	**Tafel slope (mV dec^{-1})**	**Ref.**
MoO_{3-x}	OVs	HER	0.1 M KOH	170	56	S14
NiO	OVs	HER	1 M KOH	110	100	S15
$NiCo_2O_4$	OVs	OER	0.1 M KOH	320	30	S16

Co_3O_4	OVs	OER	0.1 M KOH	220	68	S17
Fe_xCo_y-oxide	OVs	OER	0.1 M KOH	350	36.8	S18
$Ca_2Mn_2O_5$	OVs	OER	0.1 M KOH	100	149	S19
Electrocatalysts	**Defect type**	**Reactions**	**Electrolyte**	**overpotential η [mV] at 10 mA cm^{-2}**	**Tafel slope (mV dec^{-1})**	**Ref.**
$Co_{3-x}O_4$	MVs	OER	1.0 M KOH	268	38.2	S20
δ-FeOOH	MVs	HER OER	1.0 M KOH	108 265	68 53	S21

Table S3 The ntrinsic physicochemical properties of metal oxide nanomaterials and their corresponding performance for photocatalytic water splitting

Catalyst	**Size [nm]**	**Reactor/Parameter**	**Product (H_2)**	**Ref.**
Cu_2O	50 100 300 500	200 W Hg-Xe lamp, λ > 420 nm	0.007 μmol g^{-1} h^{-1} 0.009 μmol g^{-1} h^{-1} 0.012 μmol g^{-1} h^{-1} 0.013 μmol g^{-1} h^{-1}	S22
Catalyst	**Shape**	**Reactor/Parameter**	**Product (H_2)**	**Ref.**
Conventional Cu_2O Hierarchical Cu_2O	nanocubes	200 W Hg-Xe light source	~1.2 μmol g^{-1} h^{-1} 15 μmol g^{-1} h^{-1}	S23
Cu_2O	cubes concave cubes octapods	300 W Hg lamp, λ > 420 nm	24.7 μmol h^{-1} 70.5 μmol h^{-1} 145.1μmol h^{-1}	S24
TiO_2	nanotube nanorods nanosquares	250 W Xe lamp, 1.15×105 lx	4.6 mmol h^{-1} g^{-1} 2.9 mmol h^{-1} g^{-1} 2.1mmol h^{-1} g^{-1}	S25
Catalyst	**Defect type**	**Reactor/Parameter**	**Product (H_2)**	**Ref.**
$SrTiO_3$	OVs	300 W Xe lamp	2.2 mmol h^{-1} g^{-1}	S26
In_2O_3	OVs	300 W Xe lamp, λ > 420 nm	-	S27
Catalyst	**Defect type**	**Reactor/Parameter**	**Product (H_2)**	**Ref.**
TiO_2	MVs	300 W Xe lamp, λ > 420 nm	29.86 mmol h^{-1} g^{-1}	S28
Catalyst	**Crystal facets**	**Reactor/Parameter**	**Product (H_2)**	**Ref.**
TiO_2 Nanobelts	{001} and {101}	300 W Xe lamp, 400 < λ < 800 nm	670 μmol h^{-1} g^{-1}	S29
Solid TiO_2 mesoporous TiO_2	{111}	300 W Xe lamp	~80 μmol h^{-1} g^{-1} ~3.2 μmol h^{-1} g^{-1}	S30
SrTiO3	{023} and {001}	300 W Xe lamp	71.1 μmol h^{-1} 30.0 μmol /h^{-1} (O_2)	S31
Cu_2O	{100} {111} {544} {104}	300 W Hg lamp, λ > 420 nm	0.88 μmol h^{-1} 1.23 μmol h^{-1} 1.55 μmol h^{-1} 1.88 μmol h^{-1}	S32

WO_3	{002}	300W Xe lamp, λ > 420 nm	3 μmol h^{-1} cm^{-2}	S33
α-Fe_2O_3	{012} and {104} {101} and {111}	300W Xe lamp, λ > 420 nm	309.4 μmol h^{-1} g^{-1} (O_2) 3.68 μmol h^{-1} g^{-1} (O_2)	S34
$BiVO_4$	{040}	300 W Xe lamp, λ ≥ 420 nm	310 mmol h^{-1}	S35

Table S4 The ntrinsic physicochemical properties of metal oxide nanomaterials and their corresponding performance for photocatalytic reduction of CO_2

Photocatalyst	Size [nm]	Major Products	Yields	Ref.
TiO_2	4.5	CH_4	0.15 μmol h^{-1} g^{-1}	S36
	6		0.29 μmol h^{-1} g^{-1}	
	8		0.31 μmol h^{-1} g^{-1}	
	14		0.37 μmol h^{-1} g^{-1}	
	29		0.27 μmol h^{-1} g^{-1}	
Photocatalyst	**Shape**	**Major Products**	**Yields**	**Ref.**
$W_{18}O_{49}$	nanowires	CH_4	2.2 mmolL^{-1} g^{-1} h^{-1}	S37
Bi_2WO_6	nanoplates	CH_4	1.1 μmol h^{-1} g^{-1}	S38
WO_3	nanosheets	CH_4	~1.2 μmol h^{-1} g^{-1}	S39
ZnO-Cu_2O	sphere	CH_4	1080 μmol h^{-1} g^{-1}	S40
Photocatalyst	**Crystal facets**	**Major Products**	**Yields**	**Ref.**
TiO_2	{001} and {101}	CH_4	1.35 μmol h^{-1} g^{-1}	S41
Co_3O_4	{112} and {111}	CO	1672 μmol h^{-1} g^{-1}	S42
	{111}		1238 μmol h^{-1} g^{-1}	
CeO_2	{100} and {111}	CH_4	0.86 μmol h^{-1} g^{-1}	S43
BiOI	{001}	CO	0.259 μmol h^{-1}	S44
		CH_4	0.089 μmol h^{-1}	
	{100}	CO	0.076 μmol h^{-1}	
		CH_4	0.075 μmol h^{-1}	
$BiOIO_3$	{010} and {100}	CO	5.42μmol h^{-1} g^{-1}	S45

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