Electronic Supplementary Material (ESI) for Nanoscale.
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Electronic Supplementary Information (ESI)

Construction of Uniform Co–Sn–X (X = S, Se, Te) Nanocages *via* Anion Exchange Reaction with Enhanced Photovoltaics and Oxygen Evolution Properties

Qian He, Shuolin Li, Shaowei Huang, Longqiang Xiao* and Linxi Hou*

College of Chemical Engineering, Fuzhou University, Xueyuan Road No. 2, Fuzhou 350116, China. E-mail: lxhou@fzu.edu.cn; xiaolq@fzu.edu.cn.

Fax: +86-0591-2286 6244; Tel: +86-0591-2286 5220.

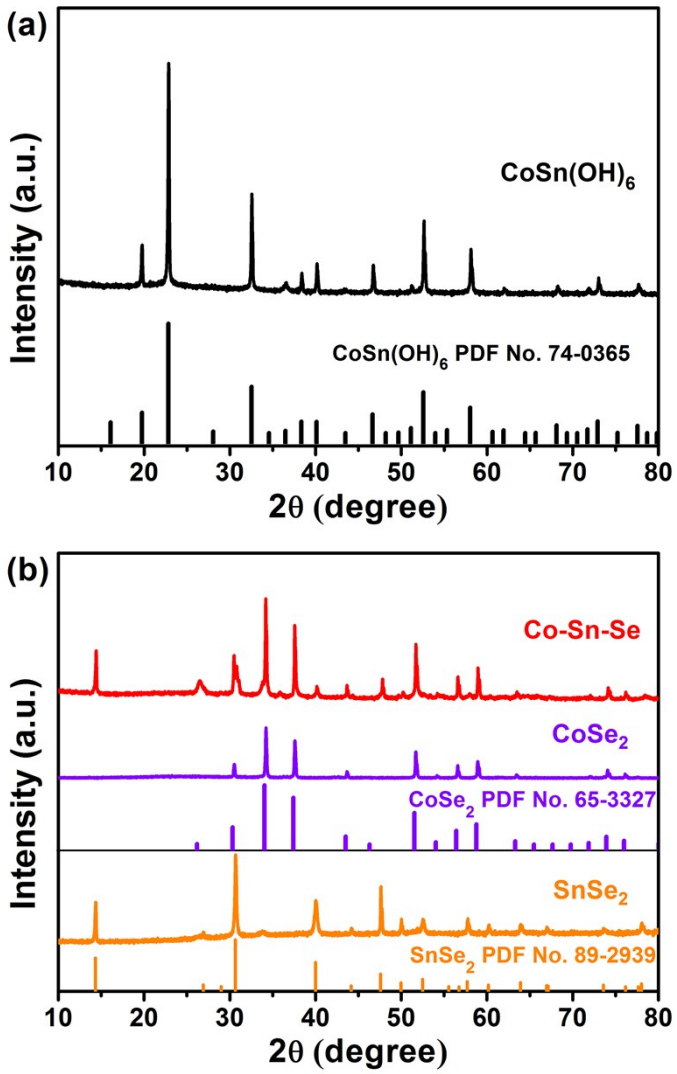

Fig. S1 XRD patterns of (a) $CoSn(OH)_6$ and (b) Co–Sn–Se, $CoSe_2$ and $SnSe_2$.

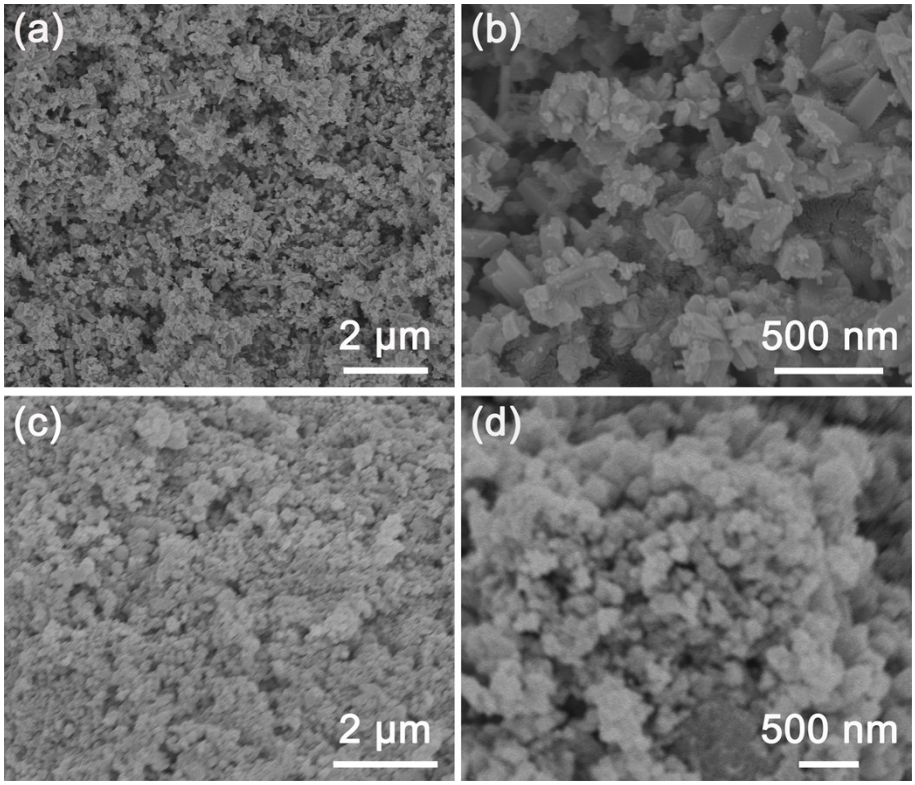

Fig. S2 SEM images of (a, b) $CoSe_2$ and (c, d) $SnSe_2$.

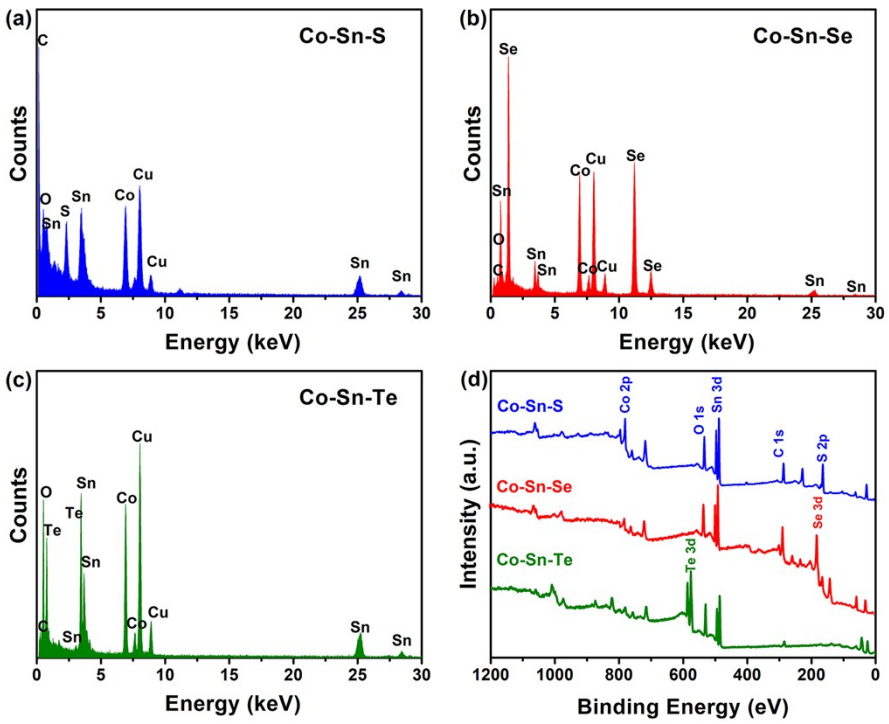

Fig. S3 The EDX spectra of (a) Co–Sn–S, (b) Co–Sn–Se and (c) Co–Sn–Te. (d) The XPS survey spectra of Co–Sn–S, Co–Sn–Se and Co–Sn–Te.

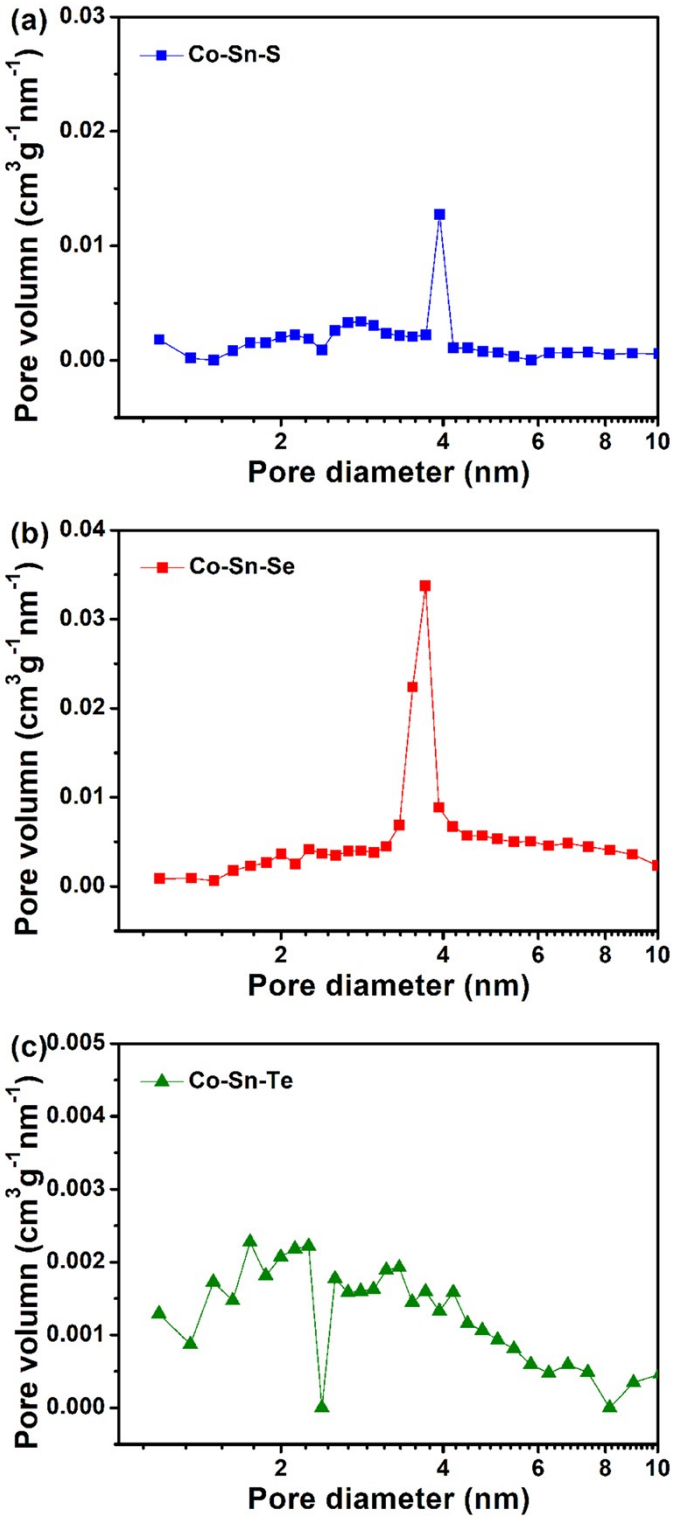

Fig. S4 The pore size distributions of (a) Co–Sn–S, (b) Co–Sn–Se and (c) Co–Sn–Te.

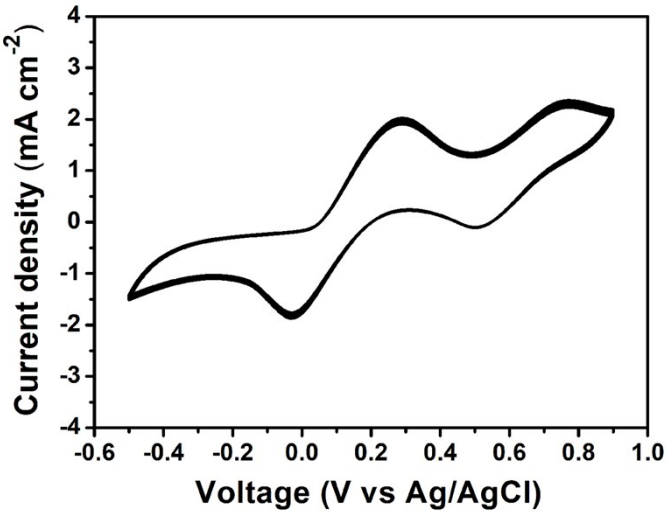

Fig. S5 CV curves of the Co–Sn–Se for 40 cycles at a scan rate of 50 mV s^{-1}.

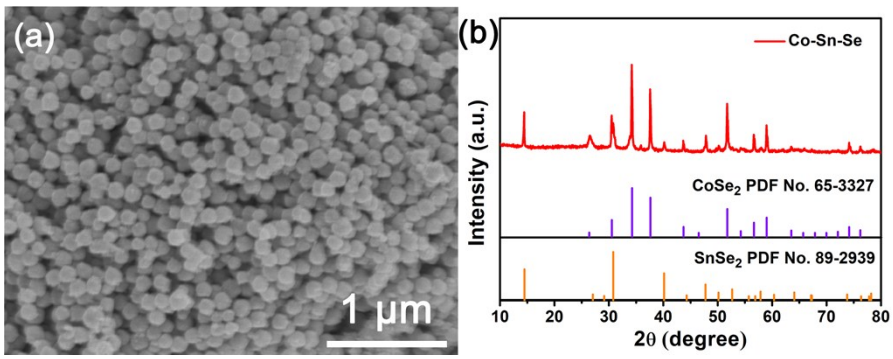

Fig. S6 (a) SEM image and (b) XRD pattern of the Co–Sn–Se nanocages after DSSCs stability test.

Table S1 Comparison of DSSCs performance for as-obtained samples with transition metal chalcogenides-based catalysts.

CE	V_{oc} (mV)	J_{sc} (mA cm^{-2})	FF	PCE (%)	References
(2D/3D) Ni_xS_y NW/NGF	730	14.22	0.72	7.72	1
$Fe_{1-x}S/Fe_3C$-NCNT-5	800	16.19	0.67	8.67	2
NiS_2/CoS_2-0.1	720	17.45	0.65	8.22	3
ZIF-ZnSe-NC-11 wt%	770	16.40	0.69	8.69	4
$NiCo_2Se_4$-H	738	16.46	0.68	8.26	5
5% Ag-doped SnS_2	740	16.70	0.70	8.70	6
SnSe	761	16.24	0.72	8.90	7
$CoIn_2S_4$	770	17.65	0.65	8.83	8
$NiTe_2$	790	14.13	0.65	7.21	9
$MoTe_2$	690	16.00	0.66	7.25	10
CoTe	620	21.40	0.60	8.10	11
Cu_3SnS_4	790	14.84	0.66	7.80	12
CoSe2/C-NCW	730	18.03	0.67	8.92	13
Co–Sn–Te	**776**	**16.40**	**0.68**	**8.72**	**This work**
Co–Sn–S	**777**	**17.20**	**0.67**	**8.91**	**This work**
Co–Sn–Se	**783**	**18.20**	**0.65**	**9.25**	**This work**

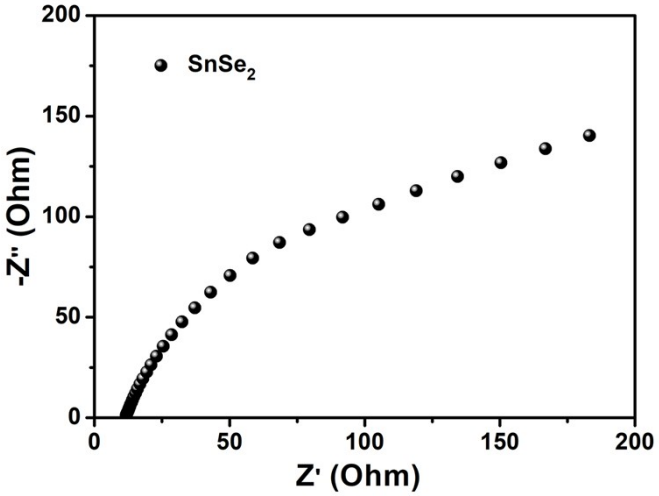

Fig. S7 Nyquist plots of the $SnSe_2$.

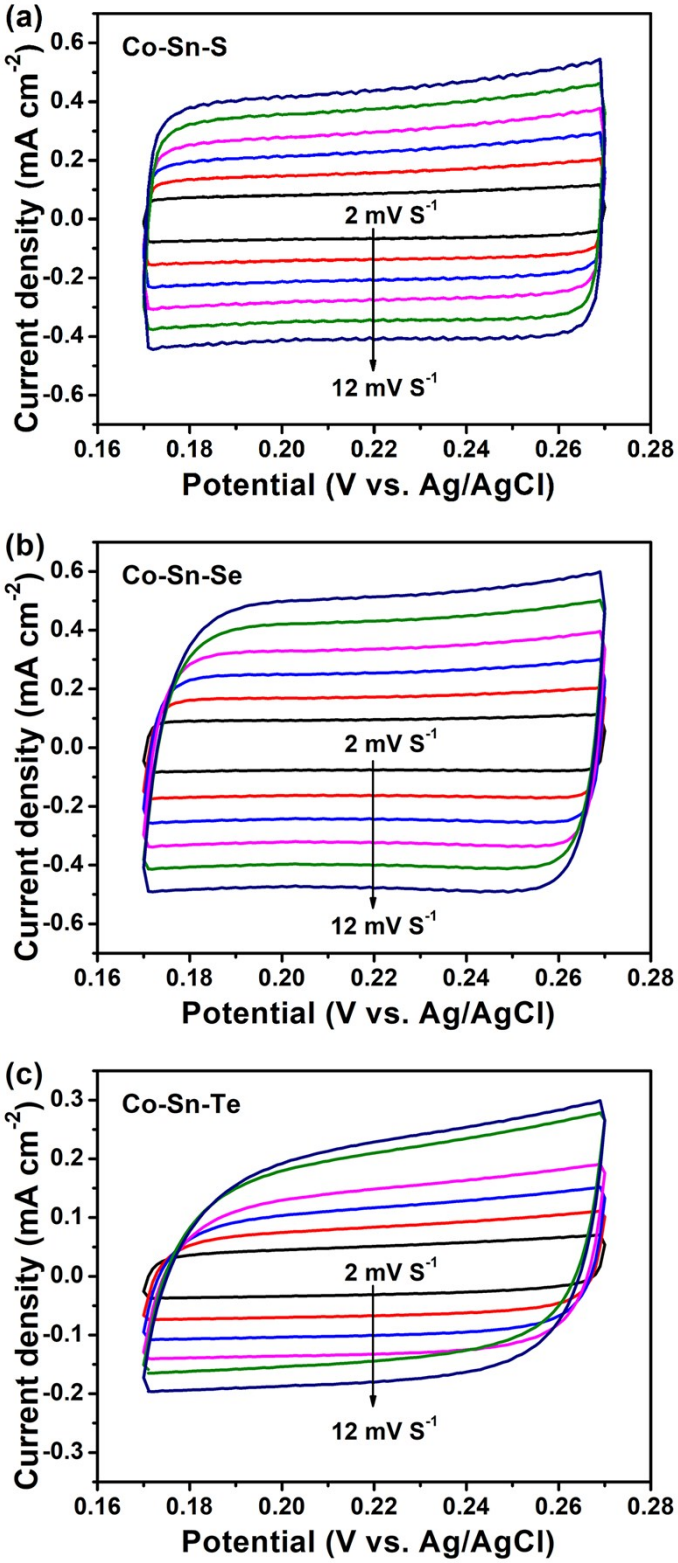

Fig. S8 CV curves of (a) Co–Sn–S, (b) Co–Sn–Se and (c) Co–Sn–Te modified electrodes in the double layer region at scan rates of 2, 4, 6, 8, 10 and 12 mV s^{-1} in 1.0 M KOH.

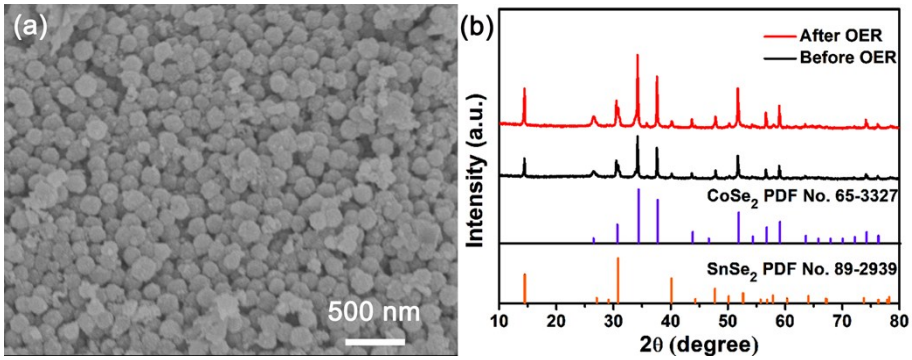

Fig. S9 (a) SEM images of the Co–Sn–Se after OER stability test. (b) The XRD spectra of the Co–Sn–Se before and after OER stability test.

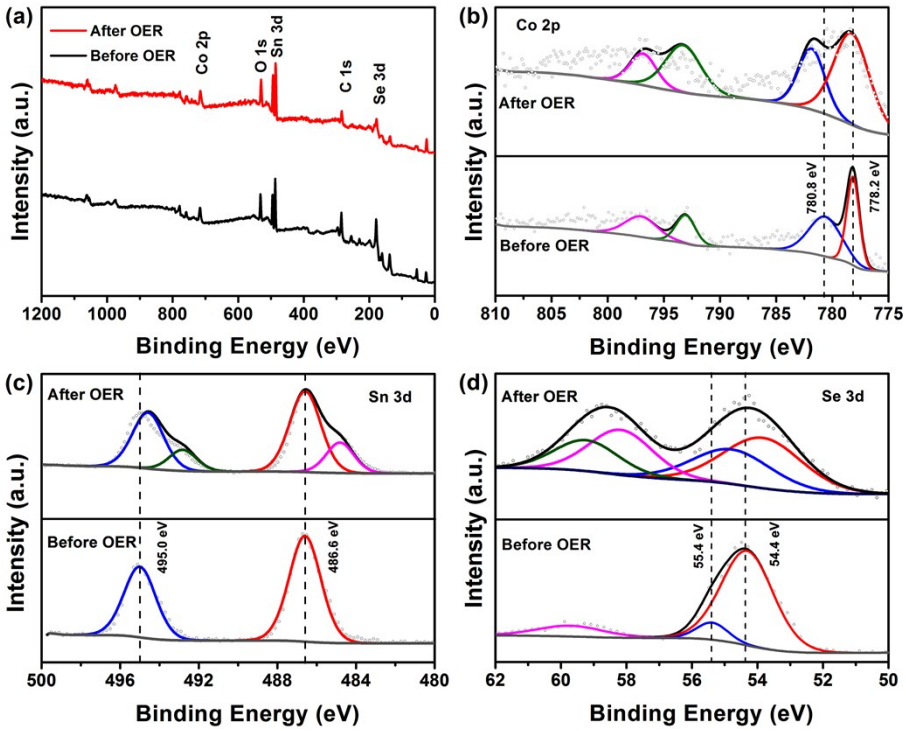

Fig. S10 (a) The XPS survey spectra and high-resolution XPS spectra for (b) Co 2p, (c) Sn 3d and (d) Se 3d of the Co–Sn–Se before and after OER stability test.

Table S2 Comparison of OER performance in alkaline medium for as-obtained samples with Co-based catalysts.

Catalysts	η (mV) at 10 mV cm^{-2}	Tafel slope (mV dec^{-1})	References
NiCoP/C	330	96	14
$Zn_{0.1}Co_{0.9}Se_2$	340	43.2	15
$(Ni,Co)Se_2$	320	89	16
Au_1–$CoSe_2$	303	42	17
$CoSe_2$-450	330	79	18
$Ni_{0.6}Co_{1.4}P$	300	80	19
FCS@N-CT	330	74	20
Zn-doped $CoSe_2$/CFC	356	88	21
$CoTe_2$	357	123	22
$NiCo_2S_4$ HSs	400	93.7	23
$Co_{1-x}S$/N–S–G	371	63	24
$CoTe_2$@NCNTFs	330	82.8	25
Co-Sn-Se	**304**	**72**	**This work**

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