Supplementary Materials

Pulse Electrolysis Technique for Preparation of Bimetal Tin-Containing Electrocatalytic Materials

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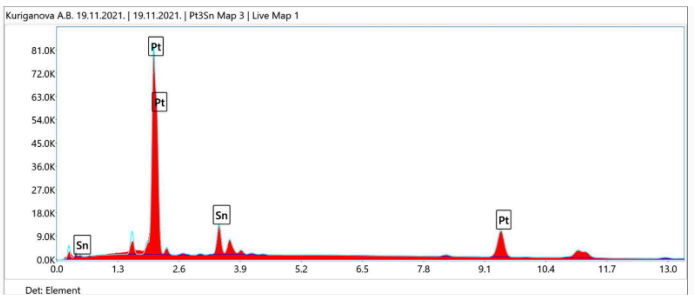

Element	Weight %	MDL	Atomic %	Net Int.	Error %	R	A	F
Sn L	17.6	0.19	26.0	778.4	6.2	0.7038	0.5557	1.0074
Pt L	82.4	0.69	74.0	1144.5	3.8	0.8602	0.9501	1.0357

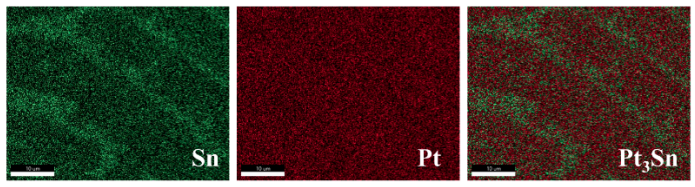

Figure S1. Results of the study of the Pt3Sn electrode by the method of energy dispersive X-ray spectroscopy.

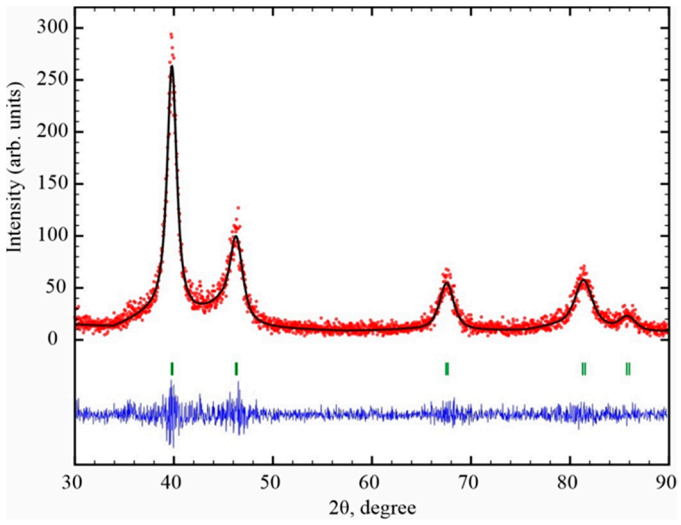

Figure S2. XRD powder pattern and Rietveld refinement plot of synthesized carbon supported Pt_3Sn sample. Red dots-observed intensity; black solid line-intensity estimated by the Rietveld refrainment; blue line-difference between the experimental and calculated intensities; green tick marks correspond to Fm3m unit cell of platinum.

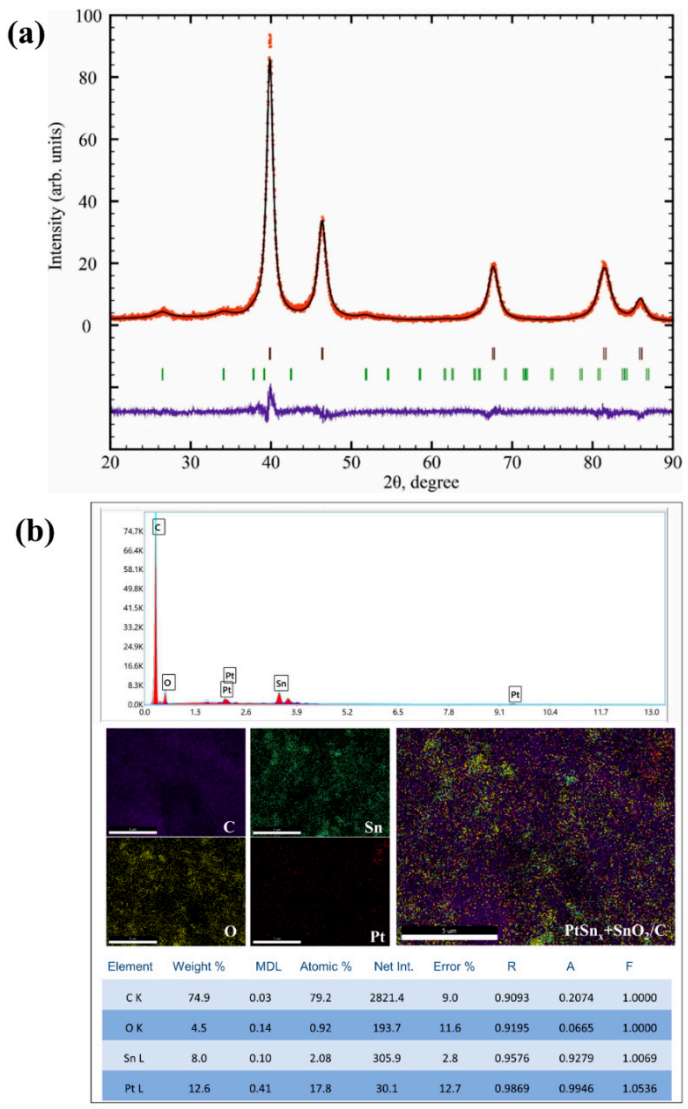

Figure S3. XRD powder pattern and Rietveld refinement plot of synthesized carbon supported $PtSn_x$ sample. Red dots-observed intensity; black solid line-intensity estimated by the Rietveld refrainment; blue line-difference between the experimental and calculated intensities; green tick marks correspond to P42/mnm unit cell of SnO_2 phase, brown tick marks correspond to Fm3m unit cell of platinum (a); results of the study of the $PtSn_x$+SnO_2/C material by the method of energy dispersive X-ray spectroscopy (b).

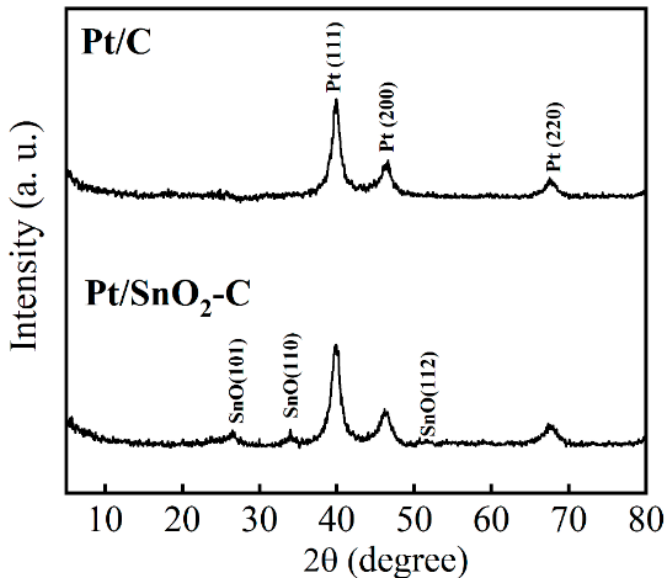

Figure S4. XRD powder pattern of Pt/C and Pt/SnO_2-C.

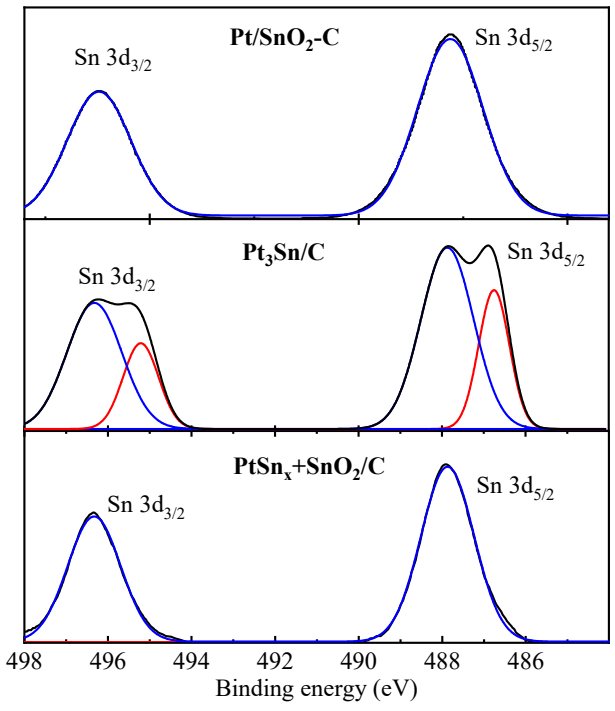

Figure S5. Sn 3d spectra of the tin-containing materials prepared via pulse electrolysis, blue line – Sn(IV), red line – Sn(0).

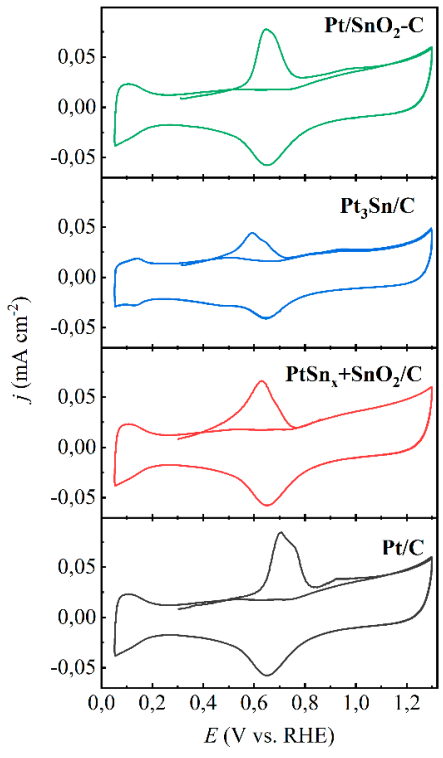

Figure S6. CO-stripping of Pt/C and platinum-tin-based materials in 0.5M H_2SO_4 scan rate 0.02 V s^{-1}

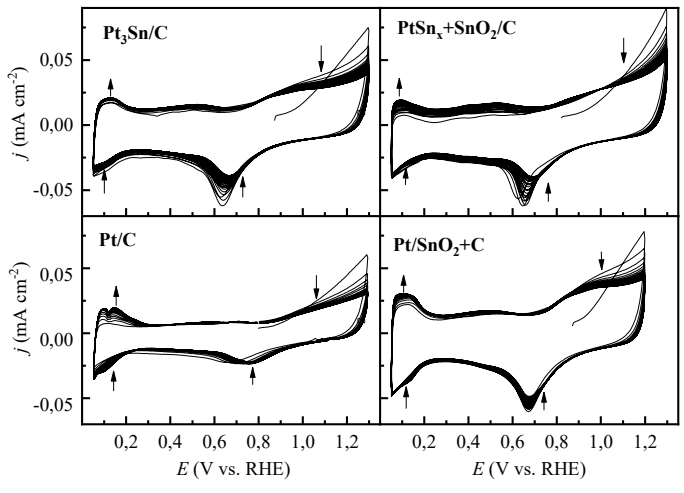

Figure S7. CV-curves of Pt/C and platinum-tin-based materials in 0.5M H_2SO_4 scan rate 0.02 V s^{-1}

Table S1. Comparison of the electrochemical properties of platinum-tin-based materials.

Sample	Method	Morphology	ECSA, $m^2 g^{-1}$	EOR		Conditions	Ref.
				E_{onset}, V (RHE)	j_{peak}, mA cm^{-2}		
Pt-Sn 3:1/C	reduction of metal precursors with formic acid	Pt-Sn alloy particles (3.1 nm) supported onto carbon black Vulcan XC-72R	–	0.55	0.5	CV, 1 M ethanol in 0.5 M H_2SO_4, scan rate 20 mV s^{-1}	[1]
Pt-Sn/C	Pt-Sn nanoparticles was achieved by the simultaneous use of oleylamineand oleic acid as solvent and capping agents, and $W(CO)_6$ as a reducing agent, respectively	Pt-Sn nanocubes (10.6 nm) supported onto carbon black Vulcan XC-72R	32.0	0.62	1.23	CV, potential range 0.05 – 0.9 V (RHE), 0.5 M H_2SO_4 + 1M EtOH, scan rate 20 mV s^{-1}	[2]
Pt-Sn/CNT	colloidal method followed by a chemical reduction	spherical nanoparticles homogeneously dispersed on the carbon nanotubes surface	–	0.68	0.141	CV, potential range 0.0 – 1.6 V (NHE), 1 M ethanol in 0.5 M H_2SO_4	[3]
Pt/SnO_2 /CNTs	*in situ* anchoring strategy	Pt (3.1 nm) and SnO_2 nanoparticles homogeneously dispersed on the carbon nanotubes surface.	28.79	0.66	–	CV, potential range 0.0 – 1.2 V (RHE), 0.5 M H_2SO_4 + 1M EtOH, scan rate 20 mV s^{-1}	[4]
Pt/SnO_2(3:1)/CB	modified Bönnemann method	Pt and SnO_2 particles dispersed on the carbon black; Pt: 3.1 ± 0.5 nm Sn: 2.5 ± 0.3 nm	–	0.32	0.80	CV, 0.5 M H_2SO_4 + 1M EtOH, scan rate 20 mV s^{-1}	[5]
$PtSn_x$+ SnO_2/C	Pulse electrolysis	Pt nanoparticles (5.6 ± 0,6 nm) doping with Sn dispersed on the SnO_2 and Vulcan XC-72	12.3±1.2	0.62	0.84	CV, potential range 0.05 – 1.5 V (RHE), 0.5 M H_2SO_4 + 0.5 M EtOH, scan rate 20 mV s^{-1}	This work
Pt/SnO_2-C		Pt nanoparticles (7.3 ± 1,0 nm) dispersed on the SnO_2 + Vulcan XC-72 support	13.1±1.5	0.62	1.19		This work
Pt_3Sn/C		Pt_3Sn alloyed particles (5.7 ± 0,8 nm) dispersed on the Vulcan XC-72 support	13.5±1.5	0.61	0.64		This work

References

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