Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary information

Insights into the solvothermal reaction for synthesizing tin(IV) oxide porous spheres

Ayano Taniguchi,[a] Rei Miyata,[a] Masataka Ohtani*[ab] and Kazuya Kobiro*[ab]

[a] Graduate School of Engineering and [b] Research Center for Structured Nanochemistry, Kochi University of Technology, 185 Miyanokuchi, Tosayamada, Kami, Kochi 782-8502, Japan.

*Corresponding authors:
ohtani.masataka@kochi-tech.ac.jp
kobiro.kazuya@kochi-tech.ac.jp

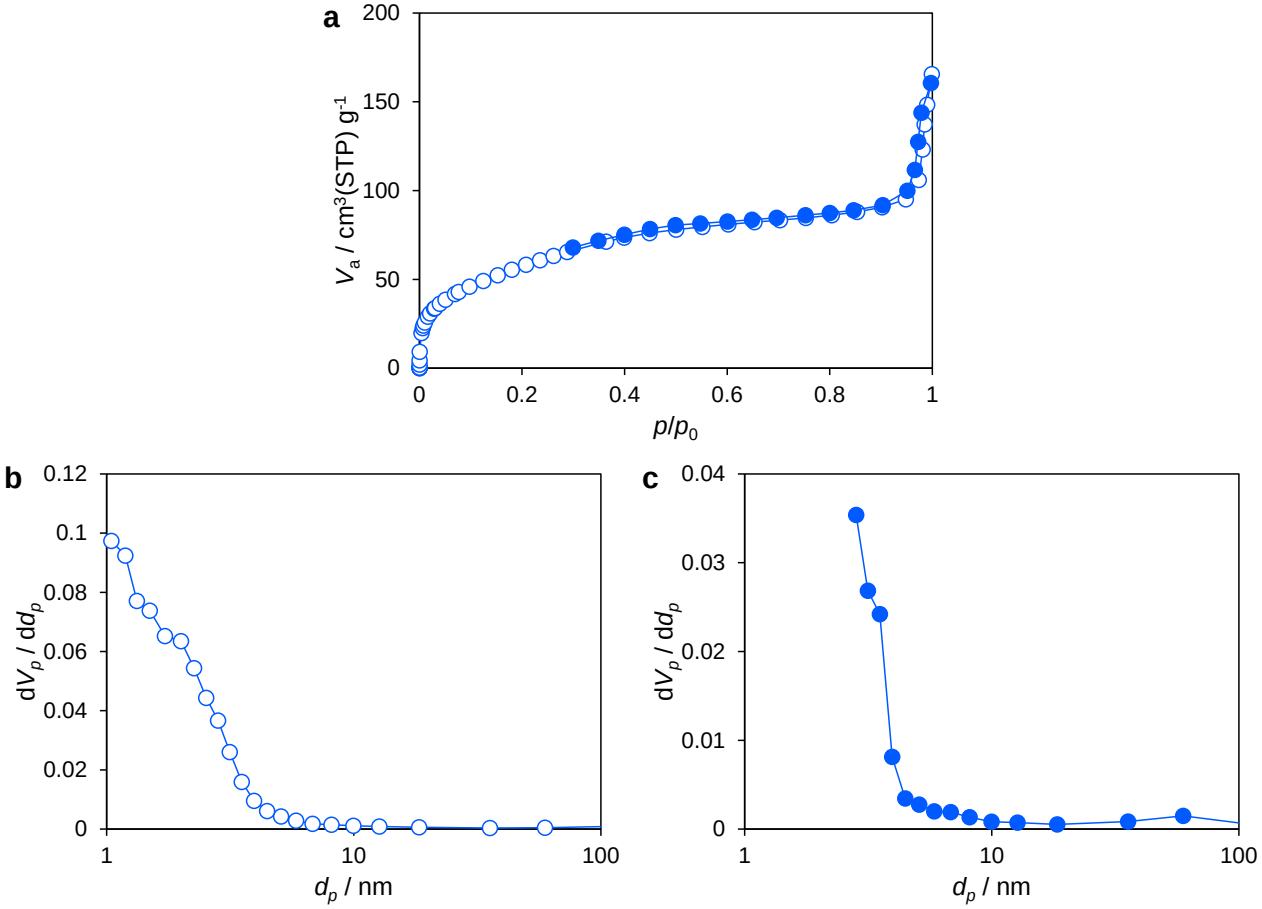


Fig. S1 Nitrogen adsorption/desorption measurement of porous SnO_2 obtained through Entry 1 in Table 4. Adsorption/desorption isotherm (a) and pore distributions (BJH plots) analyzed by adsorption (b) and desorption (c) measurement.

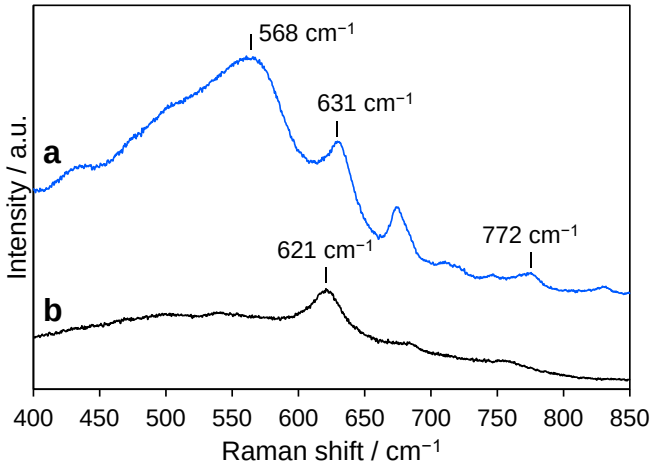


Fig. S2 Raman spectra of (a) porous SnO_2 obtained through Entry 1 in Table 4 and (b) commercially available SnO_2 (S-2000).

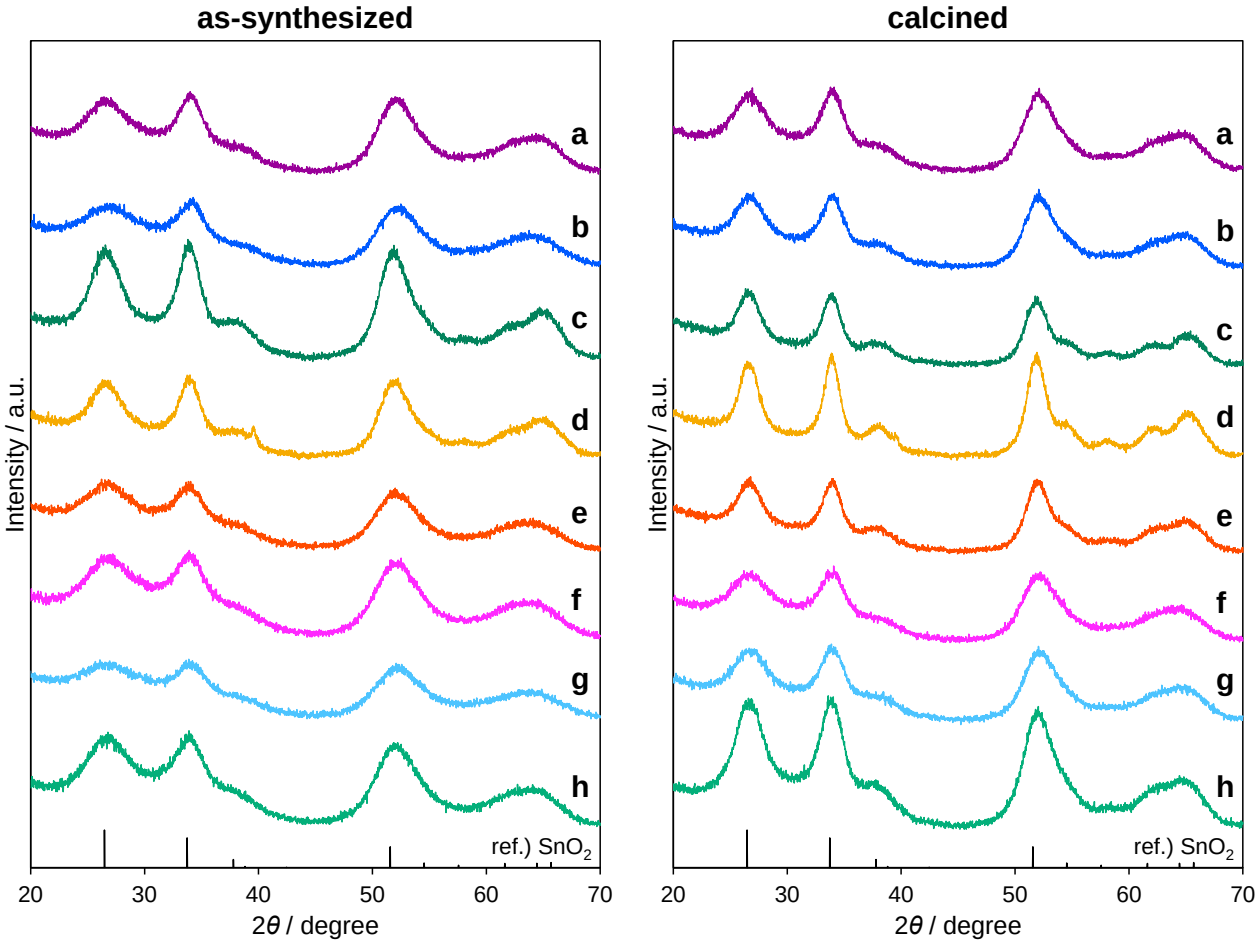


Fig. S3 XRD patterns of as-synthesized (left) and calcined (right) SnO_2-based composites. P–SnO_2 (a), V–SnO_2 (b), Nb–SnO_2 (c), Pd–SnO_2 (d), Pt–SnO_2 (e), Pt–P–SnO_2 (f), Pt–V–SnO_2 (g) and Pt–Nb–SnO_2 (h).

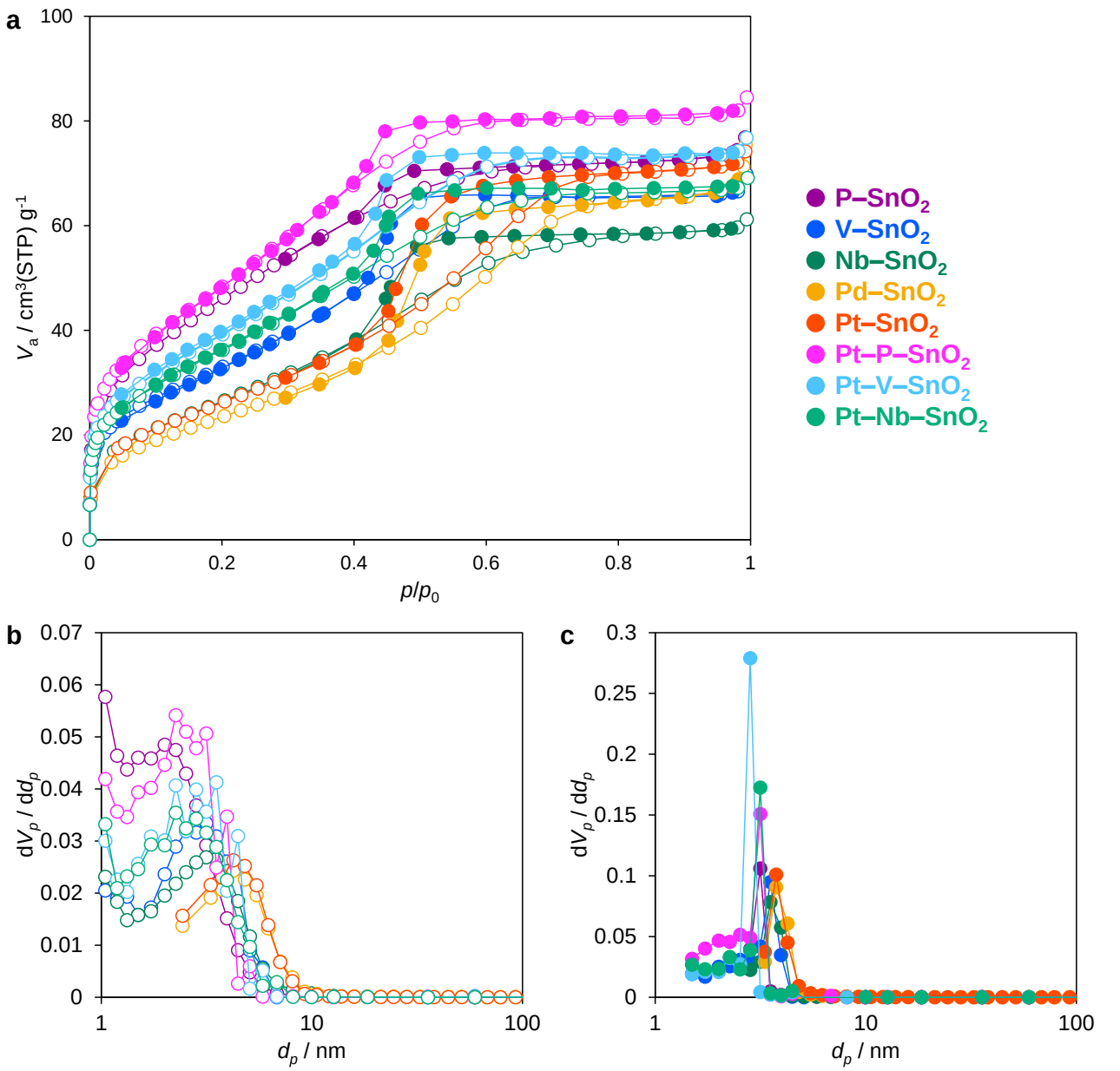


Fig. S4 Nitrogen adsorption/desorption measurement of porous SnO_2-based composites obtained through Entries 2–9 in Table 4. Adsorption/desorption isotherm (a) and pore distributions (BJH plots) analyzed by adsorption (b) and desorption (c) measurements. BELSORP-mini X was used for the measurements of P–SnO_2, V–SnO_2, Nb–SnO_2, Pt–P–SnO_2, Pt–V–SnO_2 and Pt–Nb–SnO_2. BELSORP-mini II was used for the measurements of Pd–SnO_2 and Pt–SnO_2.

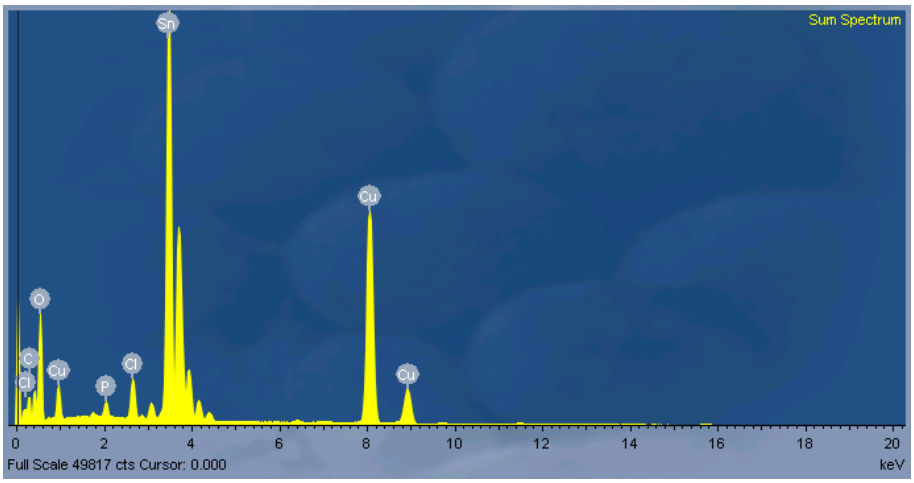


Fig. S5a EDX spectrum of P–SnO_2.

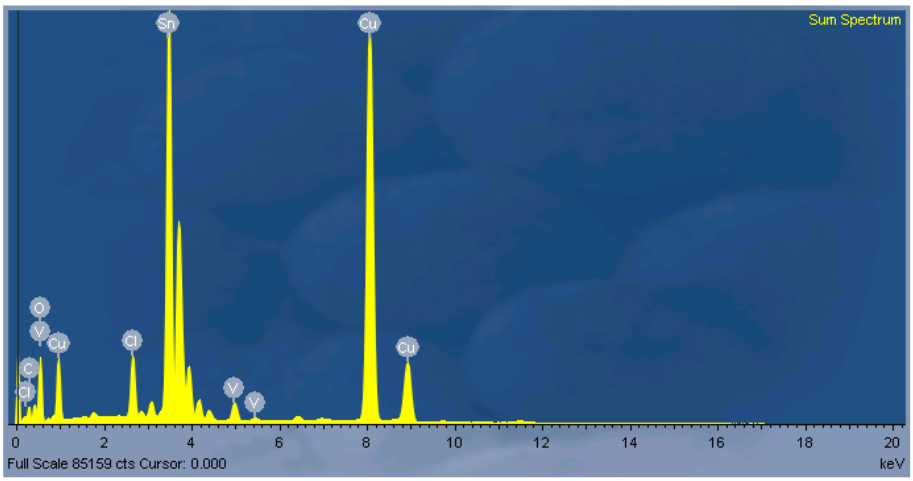


Fig. S5b EDX spectrum of V–SnO_2.

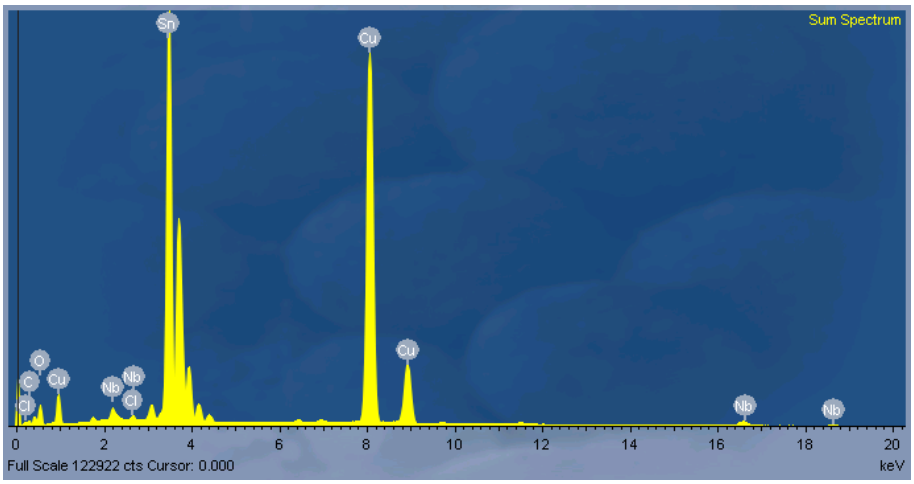


Fig. S5c EDX spectrum of Nb–SnO_2.

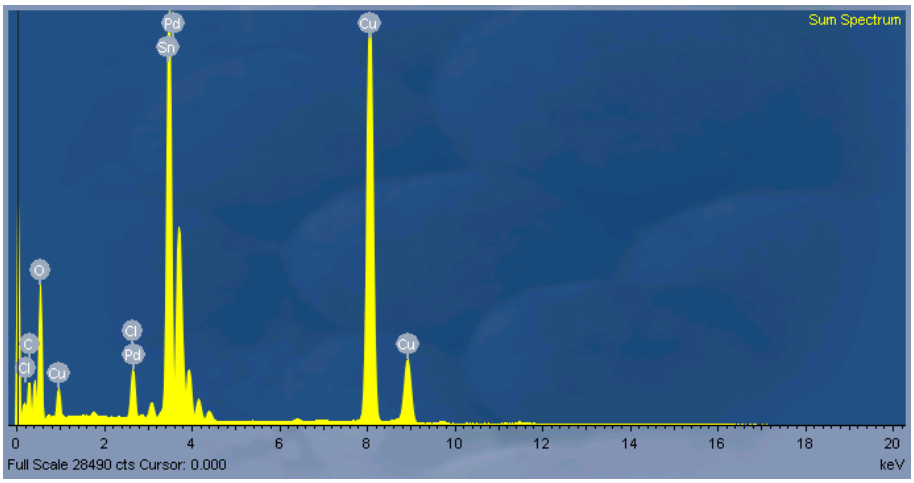


Fig. S5d EDX spectrum of Pd–SnO_2.

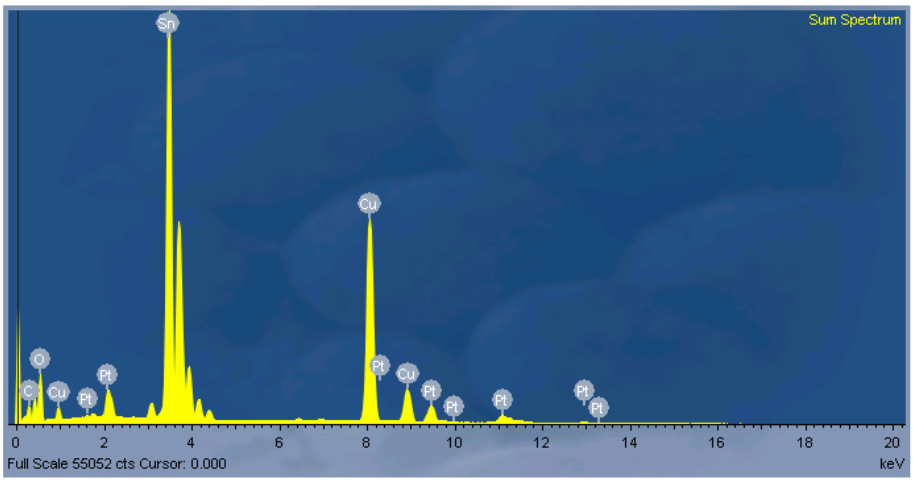


Fig. S5e EDX spectrum of Pt–SnO_2.

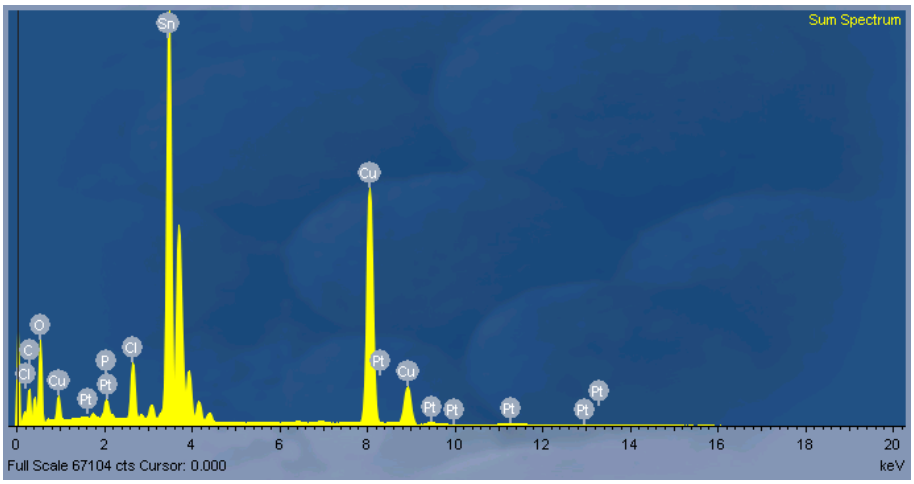


Fig. S5f EDX spectrum of Pt–P–SnO_2.

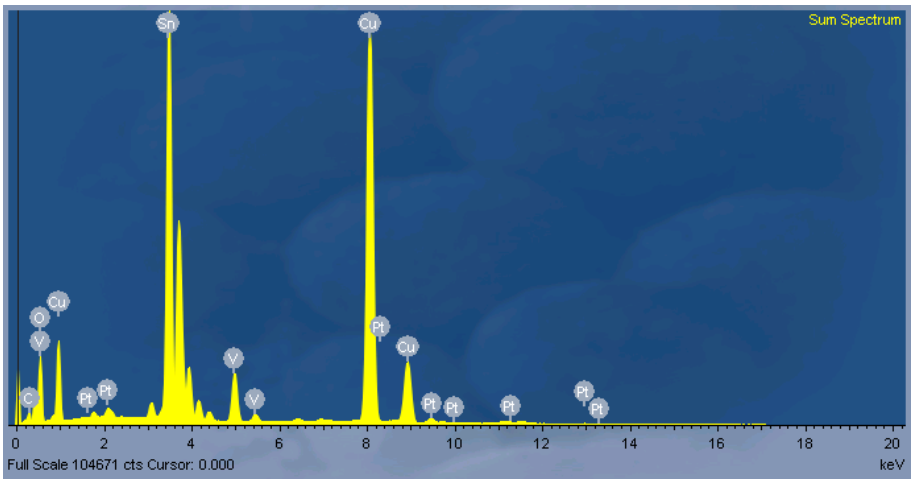


Fig. S5g EDX spectrum of Pt–V–SnO_2.

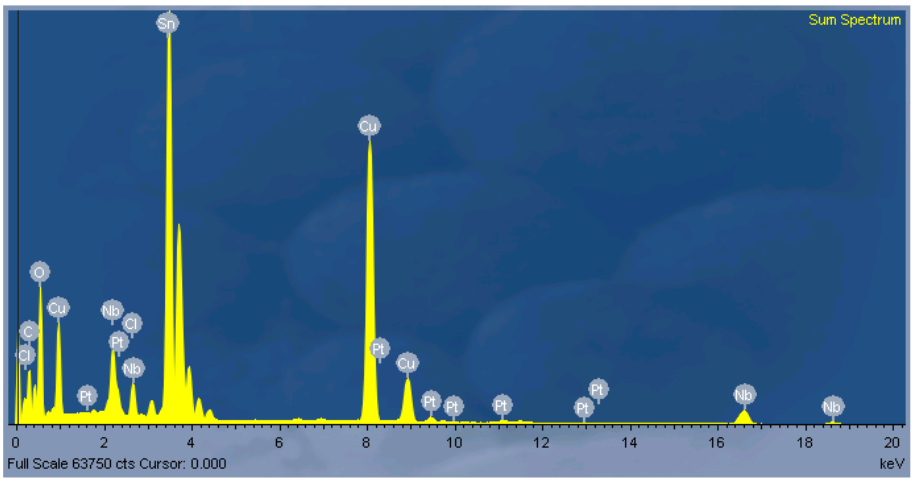


Fig. S5h EDX spectrum of Pt–Nb–SnO_2.

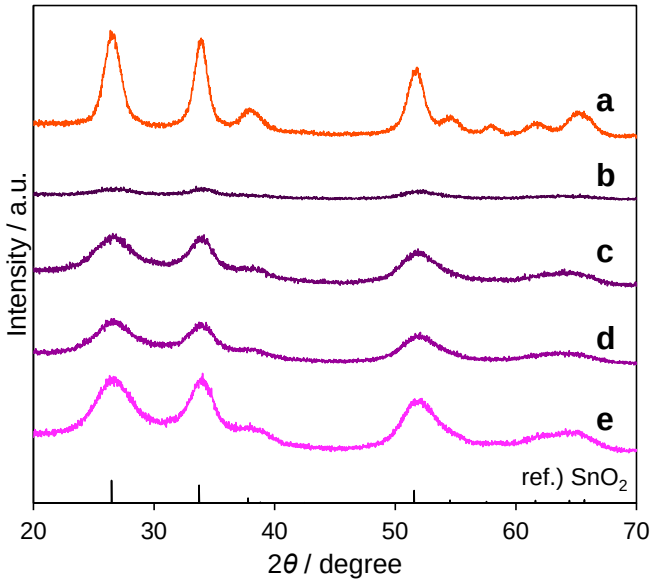


Fig. S6 XRD patterns of Rh–SnO_2 and Ru–SnO_2 corresponding to Entries 5 (a), 6 (b), 7 (c), 8 (d) and 9 (e) in Table S1.

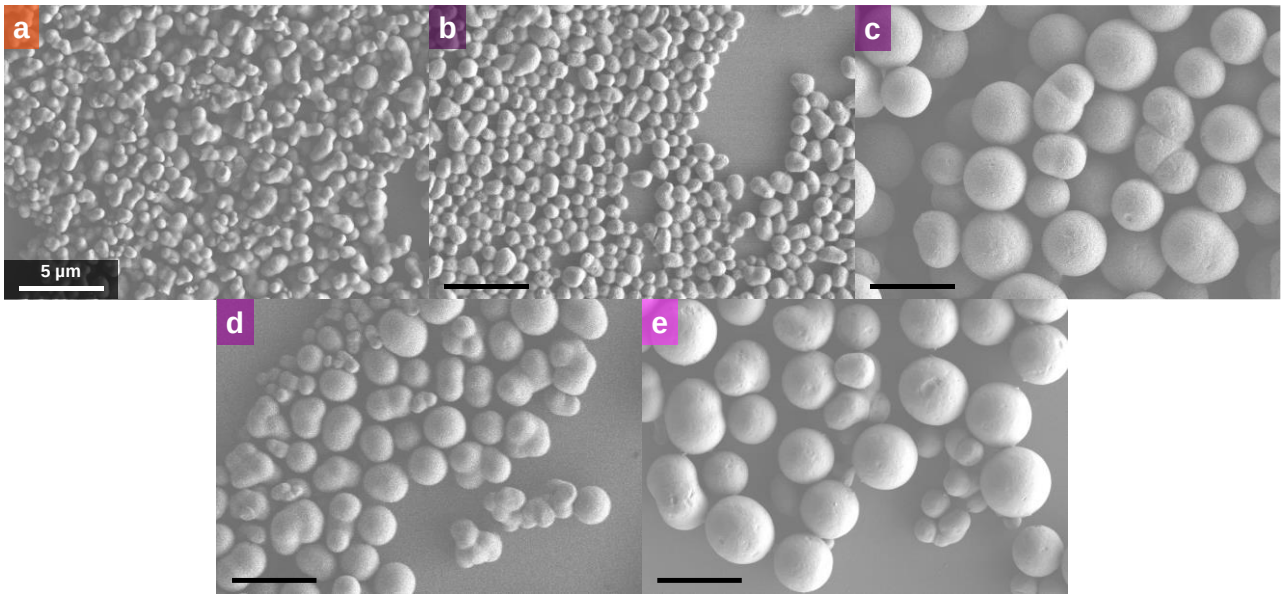
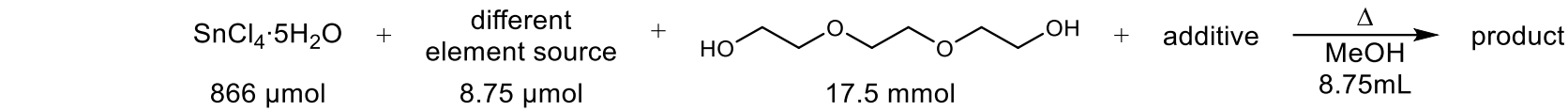


Fig. S7 SEM images of Rh–SnO_2 and Ru–SnO_2 corresponding to Entries 5 (a), 6 (b), 7 (c), 8 (d) and 9 (e) in Table S1.

Table S1 Solvothermal reaction of $SnCl_4 \cdot 5H_2O$ with different element source.[a]



Entry	Amount of reactant		Heating conditions		Product		
	Different element source	Additive (amount)	Temp. / °C	Time / min	Sample[a]	Yield / %	2nd element[c] / at%
1	$Rh(acac)_3$	-	200	60	$Rh–SnO_2$	0.15	-[d]
2	$Rh(acac)_3$	HCOOH (4.38 μmol)	200	60	$Rh–SnO_2$	0.15	-[d]
3	$Rh(acac)_3$	-	220	60	$Rh–SnO_2$	-	-[d]
4	$Rh(acac)_3$	-	200	120	$Rh–SnO_2$	3.5	-[d]
5	$Rh(acac)_3$	H_2O (1.0 mL)	200	60	$Rh–SnO_2$	85	1.1 (Rh)
6	$RuCl_3 \cdot 3H_2O$	-	200	60	$Ru–SnO_2$	89	<0.2 (Ru)
7	$RuCl_3 \cdot 3H_2O$[b]	-	200	60	$Ru–SnO_2$	89	<0.2 (Ru)
8	$RuCl_3 \cdot 3H_2O$	-	220	60	$Ru–SnO_2$	75	<0.2 (Ru)
9	$Ru(acac)_3$	-	200	60	$Ru–SnO_2$	89	<0.2 (Ru)

[a] Concentration of hetero-element (Rh or Pt) in precursor solutions is 1 at%. [b] Amount of triethylene glycol is 8.75 mmol. [c] Determined by XRF (Entries 5 and 6) and ICP-OES (Entries 7–9). [d] Not enough products to measure.