Electronic Supplementary Material (ESI) for Catalysis Science & Technology.

Supporting Information

Selective Formation of Formic Acid from Biomass-derived Glycolaldehyde with Supported Ruthenium Hydroxide Catalysts

A. Modvig and A. Riisager*

Centre for Catalysis and Sustainable Chemistry, Department of Chemistry, Technical University of Denmark, DK-2800, Kgs. Lyngby, Denmark

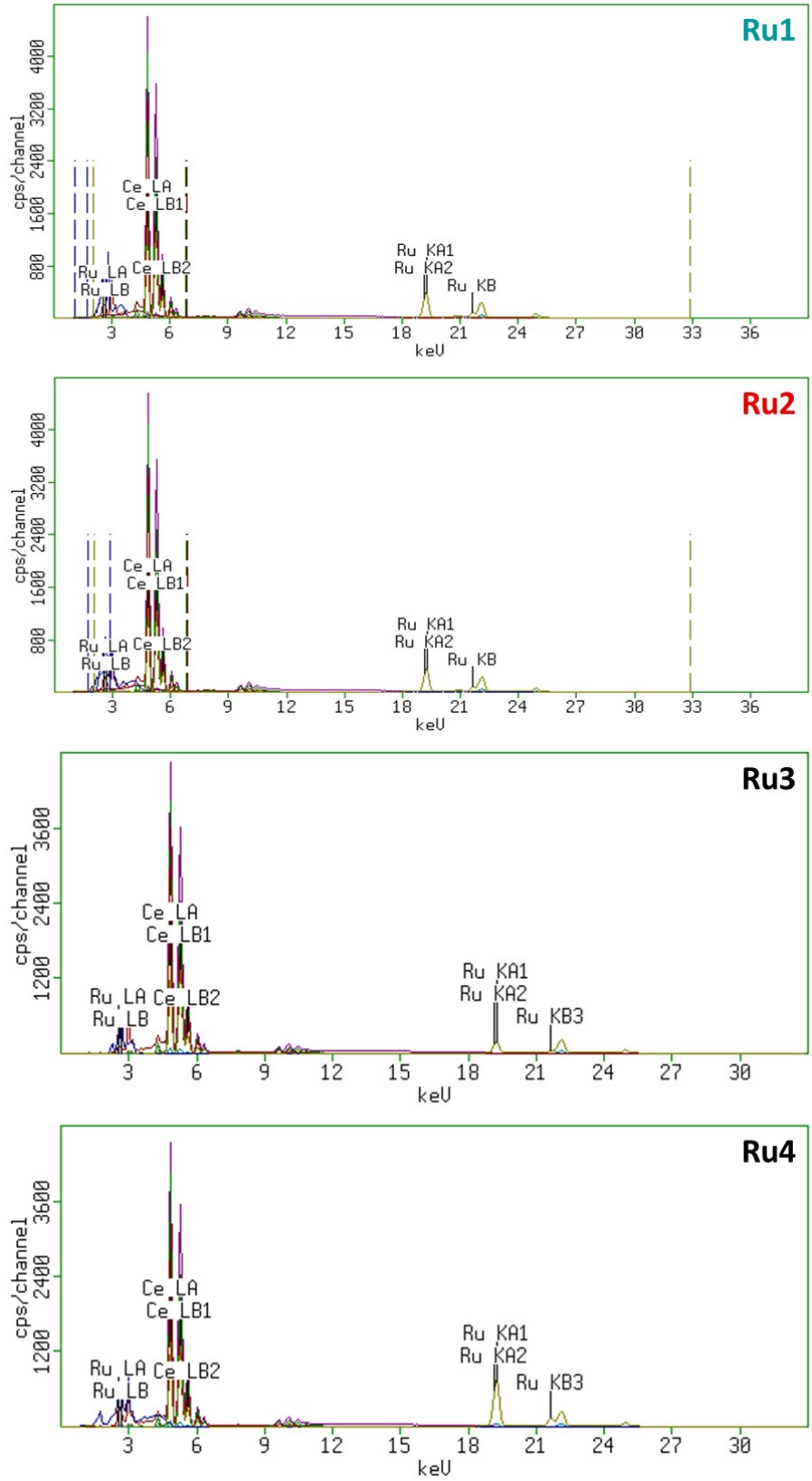

Figure S1: XRF spectra of Ru1 (1.2 wt% nanoparticles), Ru2 (1.2 wt% microparticles), Ru3 (0.6 wt% nanoparticles) and Ru4 (2.4 wt% nanoparticles).

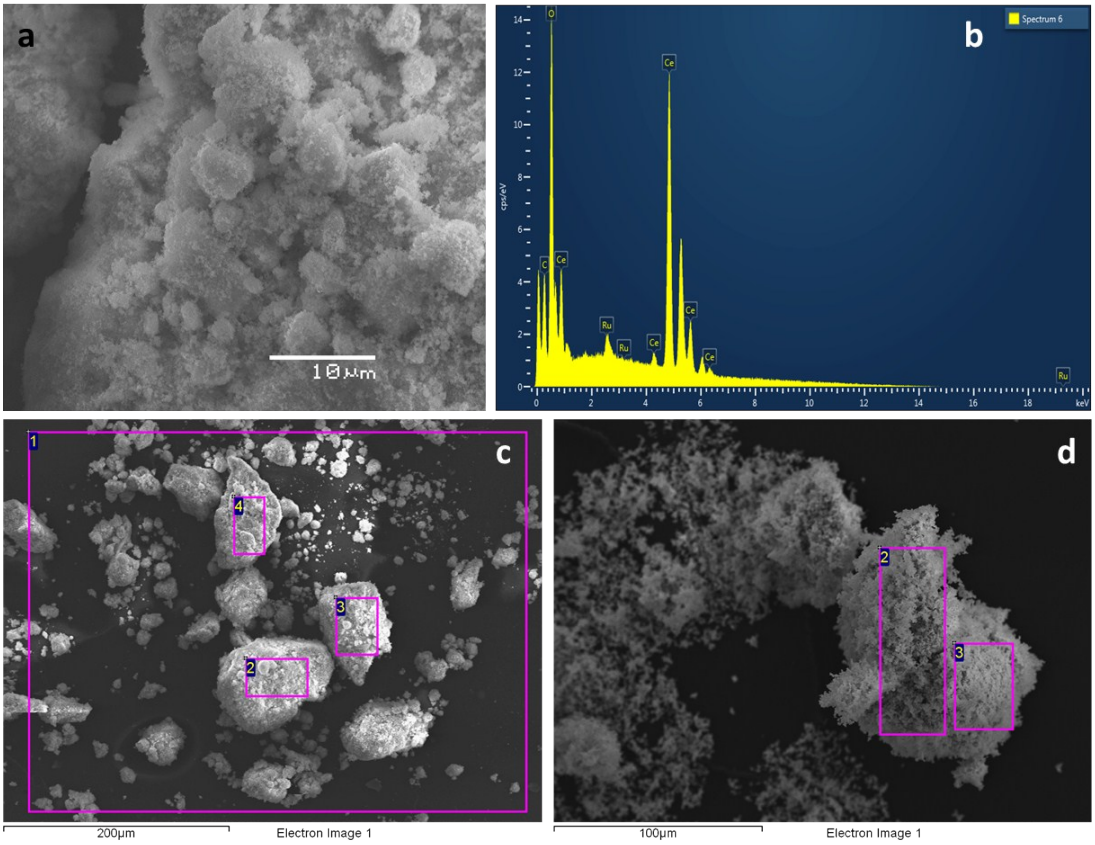

Figure S2: SEM-EDX analysis of Ru1 and Ru2. Ru1 zoom on surface (a), EDX analysis of Ru1 (b) and (c), Ru2 and (d).

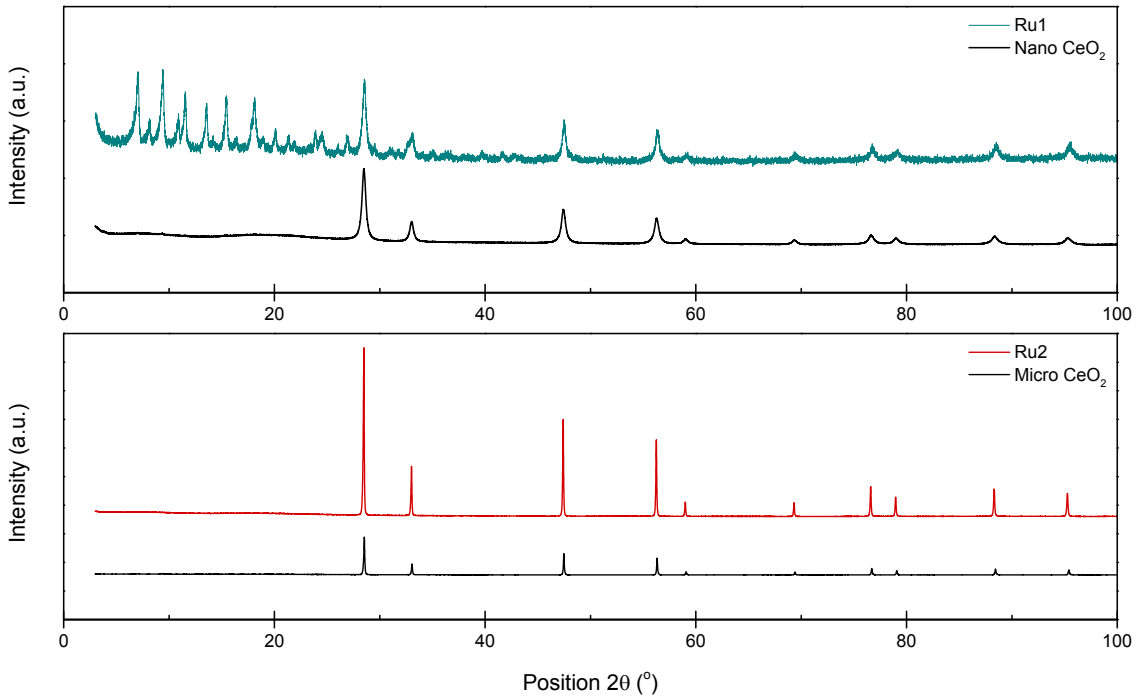

Figure S3: XRD diffractogram of Ru1 (top) and Ru2 (bottom).

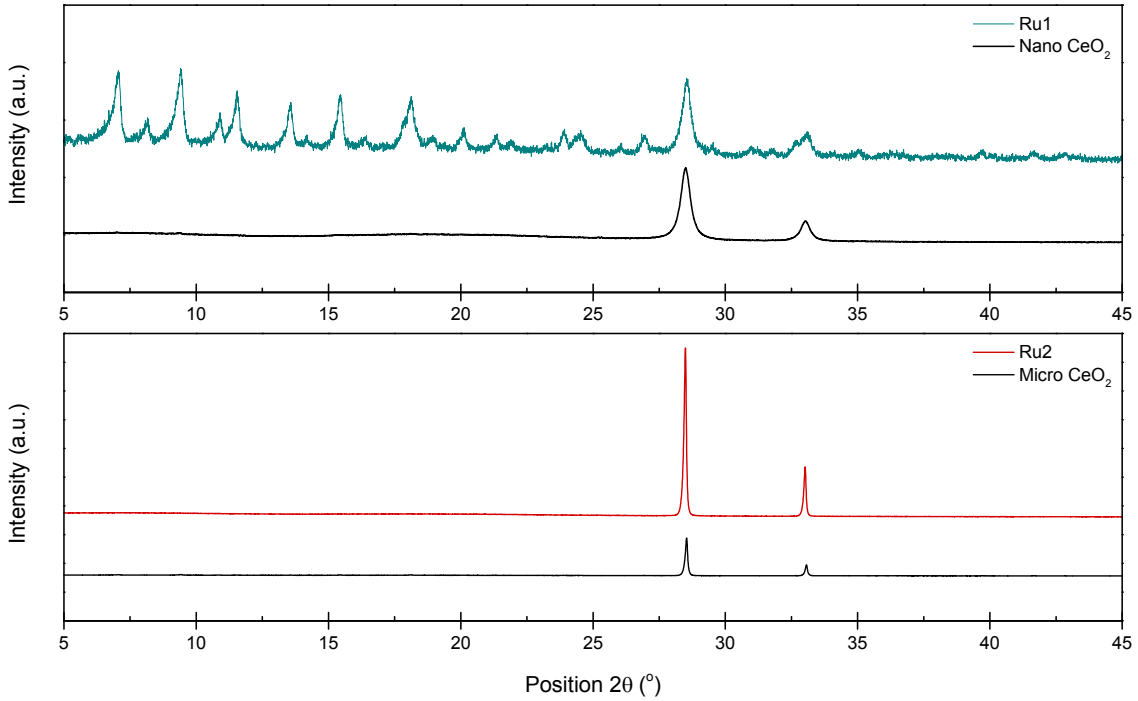

Figure S4: XRD diffractogram of Ru1 (top) and Ru2 (bottom), enlarged: 5-45°.

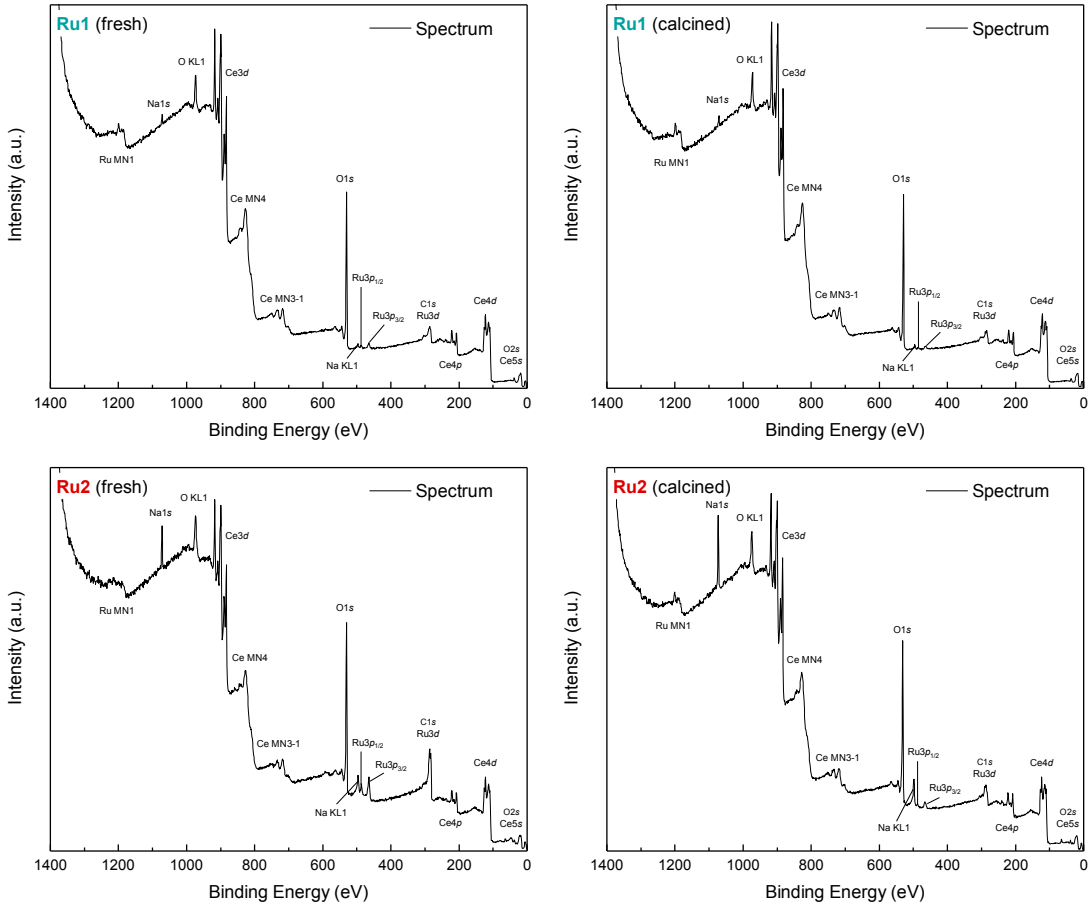

Figure S5: XPS survey of freshly prepared Ru1 and Ru2 catalysts (left) and calcined catalysts (350 °C) (right).

Table S1: Ruthenium content of modified Ru1 catalysts

Catalyst	CeO_2 support	Ru Content (wt%)[a]		
		Theoretical	XRF	EDX
Ru3	Nano	0.6	0.4 (0.1)	0.4 (0.1)
Ru4	Nano	2.4	1.7 (0.2)	2.3 (1.2)

[a] Standard deviation in parentheses.

Table S2: Convoluted XPS results of the Ru3$p_{3/2}$ region.

Catalyst/ Ru-specie	Fresh				Calcined			
	BE[a] (eV)	FWHM[b] (eV)	Area (CPSxeV)	Area (%)	BE[a] (eV)	FWHM (eV)	Area (CPSxeV)	Area (%)
Ru1								
RuO_3	467.3	3.5	1127.8	21.1	466.8	3.5	780.8	24.3
$Ru(OH)_x$	464.4	3.5	3808.1	71.1	464.5	3.5	1129.6	35.1
RuO_2	463.7	1.9	288.3	5.4	463.6	3.5	1183.7	36.8
Ru^0	460.8	1.8	129.0	2.4	459.2	1.2	120.1	3.7
Ru2								
RuO_3	467.0	3.5	1437.1	16.1	467.8	3.4	760.5	14.9
$Ru(OH)_x$	464.4	3.4	5232.7	58.5	465.8	2.4	875.7	17.2
RuO_2	463.1	2.3	2010.0	22.5	464.0	3.5	3199.7	62.7
Ru^0	461.3	1.6	262.1	2.9	462.3	2.9	266.8	5.2

[a] BE = Binding Energy, [b] FWHM = Full With at Half Maximum.