Supplementary Information

Synthetic Niobium Oxyhydroxide as a Bifunctional Catalyst for Production of Ethers and Allyl Alcohol from Waste Glycerol

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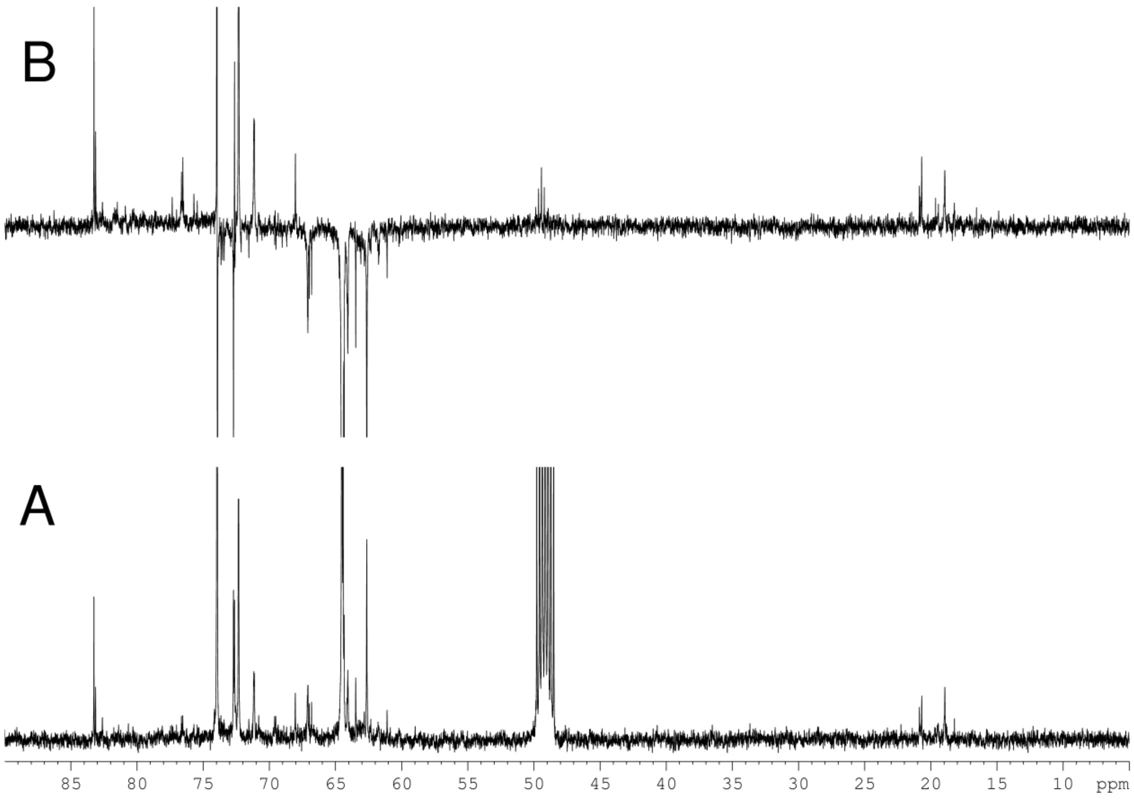

Figure S1. (A) Partial ^{13}C NMR and (B) DEPT-135 NMR spectra of CP-3h at 300 K (400 MHz, CD_3OD-d_4).

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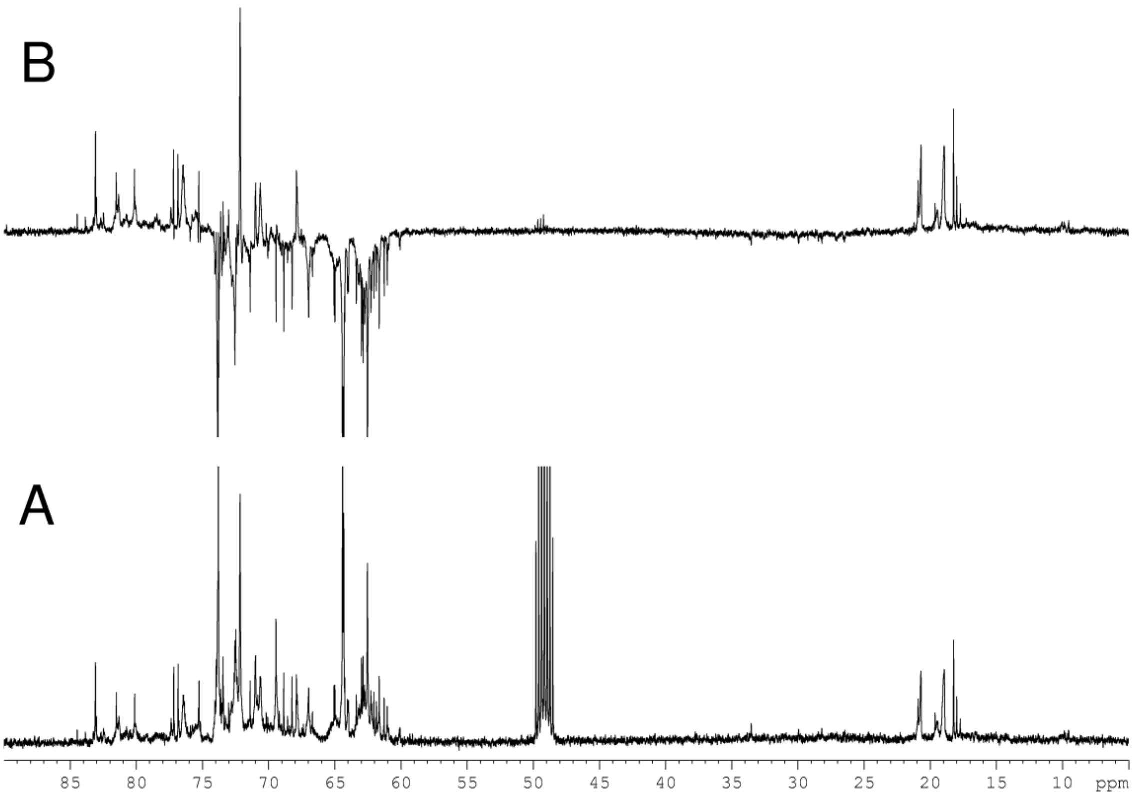


Figure S2. (A) Partial ^{13}C NMR and (B) DEPT-135 NMR spectra of CP-6h at 300 K (400 MHz, CD_3OD-d_4).

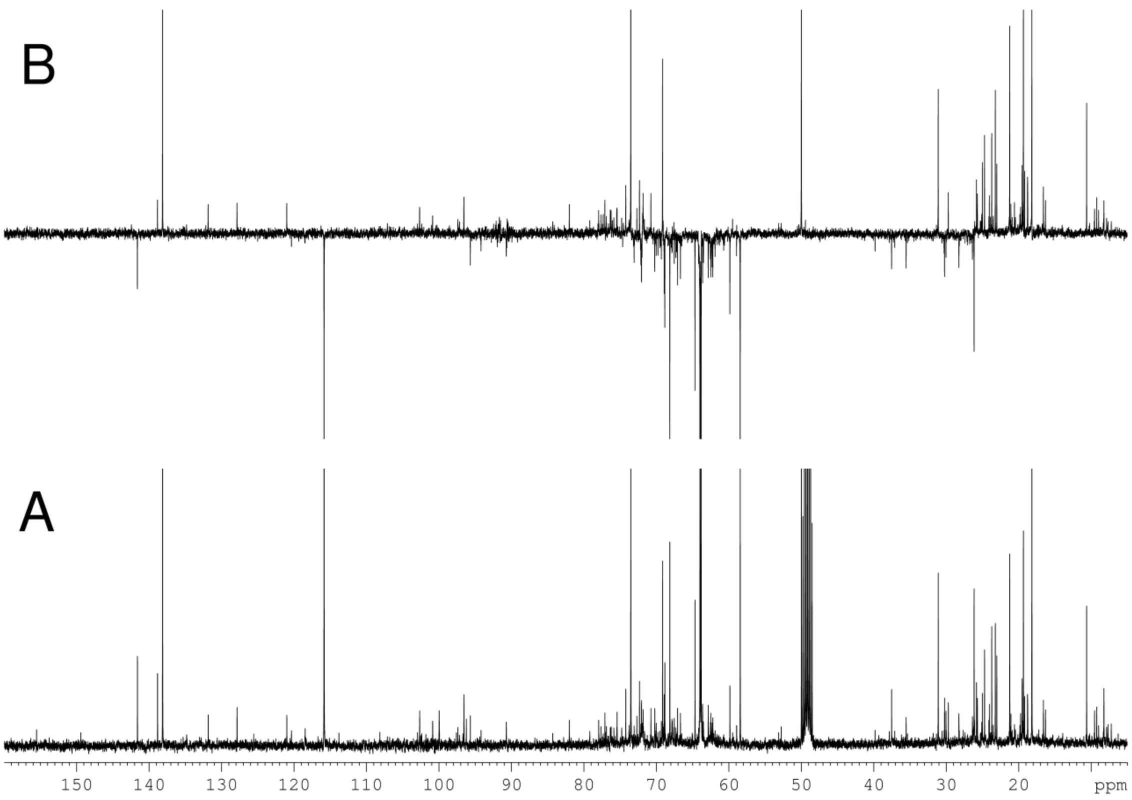
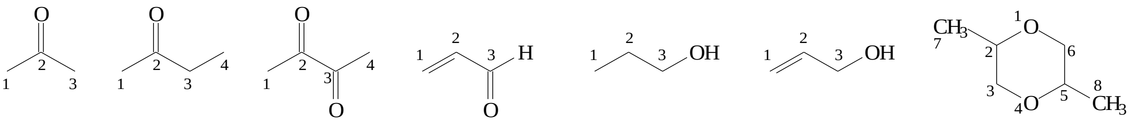


Figure S3. (A) Partial ^{13}C NMR and (B) DEPT-135 NMR spectra of VP-6h at 300 K (400 MHz, CD_3OD-d_4).

Table S1. NMR of ^{13}C and ^{1}H parameters used on molecules identification



acetone | butanone | 2,3-butanedione | acrolein | propyl alcohol | allyl alcohol | 2,5-dimethyl-1,4-dioxane

Position	^{13}C chemical shift / ppm	^{1}H chemical shift / ppm	Phase in DEPT-135	HMBC correlation
		Acetone		
1	31.1	2.17	+	$^{3}J_{H3\text{-}C1}$
2	213.9	NHC	NHC	$^{2}J_{H1\text{-}C2}$, $^{2}J_{H3\text{-}C2}$
3	31.1	2.17	+	$^{3}J_{H1\text{-}C3}$
		Butanone		
1	29.7	2.15	+	
2	216.1	NHC	NHC	$^{2}J_{H1\text{-}C2}$, $^{2}J_{H3\text{-}C2}$, $^{3}J_{H4\text{-}C2}$
3	37.5	2.51	–	$^{3}J_{H1\text{-}C3}$, $^{2}J_{H2\text{-}C3}$
4	8.2	0.97	+	$^{2}J_{H3\text{-}C4}$
		2,3-Butanedione		
1	23.7	2.27	+	
2	199.6	NHC	NHC	$^{2}J_{H1\text{-}C2}$
3	199.6	NHC	NHC	$^{2}J_{H4\text{-}C3}$
4	23.7	2.27	+	
		Acrolein		
1	198.7	9.474	+	$^{3}J_{H3a\text{-}C1}$, $^{3}J_{H3b\text{-}C1}$
2	138.9	6.36	+	$^{2}J_{H1\text{-}C2}$, $^{2}J_{H3a\text{-}C2}$, $^{2}J_{H3b\text{-}C2}$
3	139.5	a: 6.46 b: 6.63	–	
		Propyl alcohol		
1	64.7	3.49	–	$^{2}J_{H2\text{-}C1}$, $^{3}J_{H3\text{-}C1}$
2	26.2	1.51	–	$^{2}J_{H1\text{-}C2}$, $^{2}J_{H3\text{-}C2}$
3	10.6	0.87	+	$^{3}J_{H1\text{-}C3}$, $^{2}J_{H2\text{-}C3}$
		Allyl alcohol		
1	63.8	4.05	–	$^{2}J_{H2\text{-}C1}$, $^{3}J_{H3a\text{-}C1}$, $^{3}J_{H3b\text{-}C1}$
2	138.1	5.94	+	$^{2}J_{H3a\text{-}C2}$, $^{2}J_{H3b\text{-}C2}$
3	115.9	a: 5.10 b: 5.23	–	$^{3}J_{H1\text{-}C3}$
		Cyclic ether		
2	69.2	3.79	+	$^{2}J_{H3\text{-}C2}$, $^{2}J_{H7\text{-}C2}$
3	68.2	3.42	–	$^{2}J_{H2\text{-}C3}$, $^{3}J_{H7\text{-}C3}$
5	69.2	3.79	+	$^{2}J_{H6\text{-}C5}$, $^{2}J_{H8\text{-}C5}$
6	68.2	3.42	–	$^{2}J_{H5\text{-}C6}$, $^{3}J_{H8\text{-}C6}$
7	19.3	1.11	+	$^{2}J_{H2\text{-}C7}$, $^{3}J_{H3\text{-}C7}$
8	19.3	1.11	+	$^{2}J_{H5\text{-}C8}$, $^{3}J_{H6\text{-}C8}$

NHC: resonances of non-hydrogenated carbons are not observed in this experiment.