Base-free conversion of glycerol to methyl lactate using a multifunctional catalytic system consisting of Au-Pd nanoparticles on carbon nanotubes and Sn-MCM-41-XS

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Supporting Information

Table S1. Comparison with previously reported heterogeneous catalysts for the production of methyl lactate from glycerol oxidation and rearrangement, which operate without requiring the addition of a homogeneous base.

Entry	Catalyst	Temp. /ºC	Time _ /h	glycerol/metal		Oxidan	Pressu	Conv.	Y_{ML}	Def
				(mol/mol)	(g/g)	t	re/bar	(%)	(%)	Kel.
1	Au/USY	160	10	1407	657	air	30	95	73	1
2	Au/Sn-USY	160	10	95	44	02	5	88	79	2
3	Au/CuO + Sn-MCM-41-XS	140	9.5ª	985	460	air	30	95	63	3
4	AuPd/CNT-NS + Sn-MCM-41-XS	140	9ª	760	460	air	30	96	85	This work

 $^{\rm a}$ Reaction time at 140 °C (heating time: 0.5 h).



Figure S1. Correlation between oxygen content (mol %) and number of total acid sites for the pure and the treated carbon nanotubes (graph based on the data in Table 2 of the main text).



Figure S2. Visualisation of the dispersion of functionalised carbon nanotubes in water (top) and of the deposition of one drop of such suspension on filter paper (bottom).



Figure S3. Conversion of glycerol and products selectivity over the catalytic system consisting of AuPd/CNTs-S and Sn-MCM-41-XS, as a function of the air pressure used in the reaction.



Figure S4. Plot of the natural logarithm of the concentration of glycerol as a function of reaction time for the test carried out with the catalytic system consisting of AuPd/CNTs-S and Sn-MCM-41-XS. Reaction conditions: 0.25 M glycerol in 20 ml methanol; 0.1 g AuPd/CNTs-S; 0.2 g of Sn-MCM-41-XS; 140 °C; 30 bar air.





MCM-41-XS; temperature: 140 °C; air pressure: 30 bar; reaction time: 4.5 h.



Figure S6. TEM picture of the catalytic system consisting of AuPd/CNTs-NS and Sn-MCM-41-XS after 5 consecutive runs.

Table S2. Elemental analysis of the catalysts before and after 5 runs, as determined by inductively coupled plasma - optical emission spectrometry (ICP-OES).

Catalyst	Au + Pd loading in AuPd/CNT (wt.%)	Molar ratio Au/Pd	Molar ratio Si/Sn	
AuPd/CNT + Sn-MCM-41-XS	1.03	1.2 : 1	67:1	
AuPd/CNT-NS + Sn-MCM-41-XS (after 5 runs)	n.a.	1.2 : 1	67:1	



Figure S7. TEM picture of Sn-MCM-41-XS. The specific surface are of different batches of this material were in the range 985 to 1060 m²/g.

References

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