

Support Information

A very simple method to synthesize nano-sized manganese oxide: An efficient catalyst for water oxidation and epoxidation of olefins

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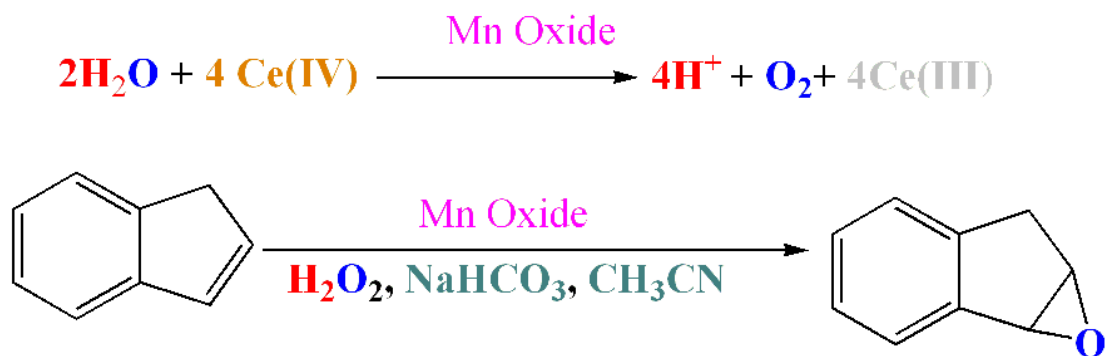
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Scheme S1. Chemical equations for the studied reactions.

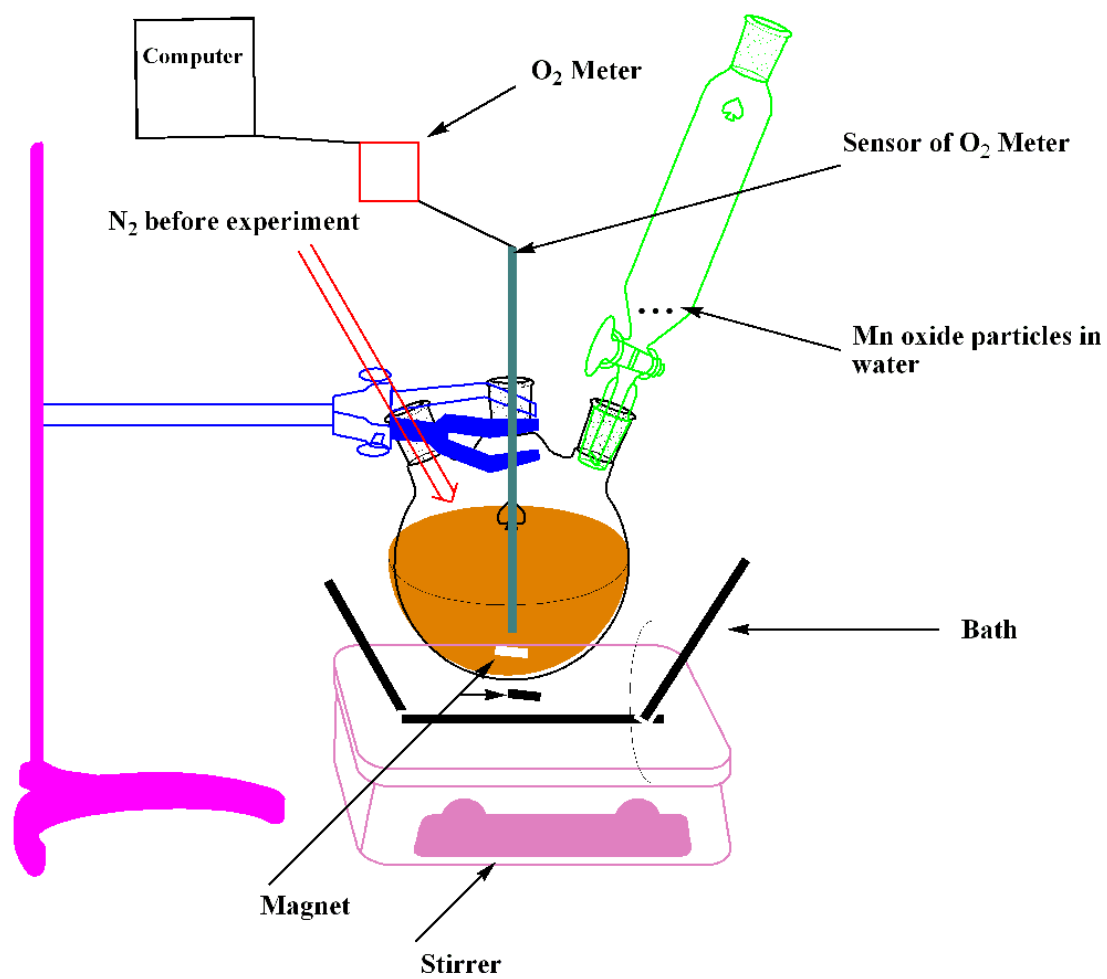


Fig. S1. The reactor set-up for oxygen evolution experiment in the presence of Ce(IV).

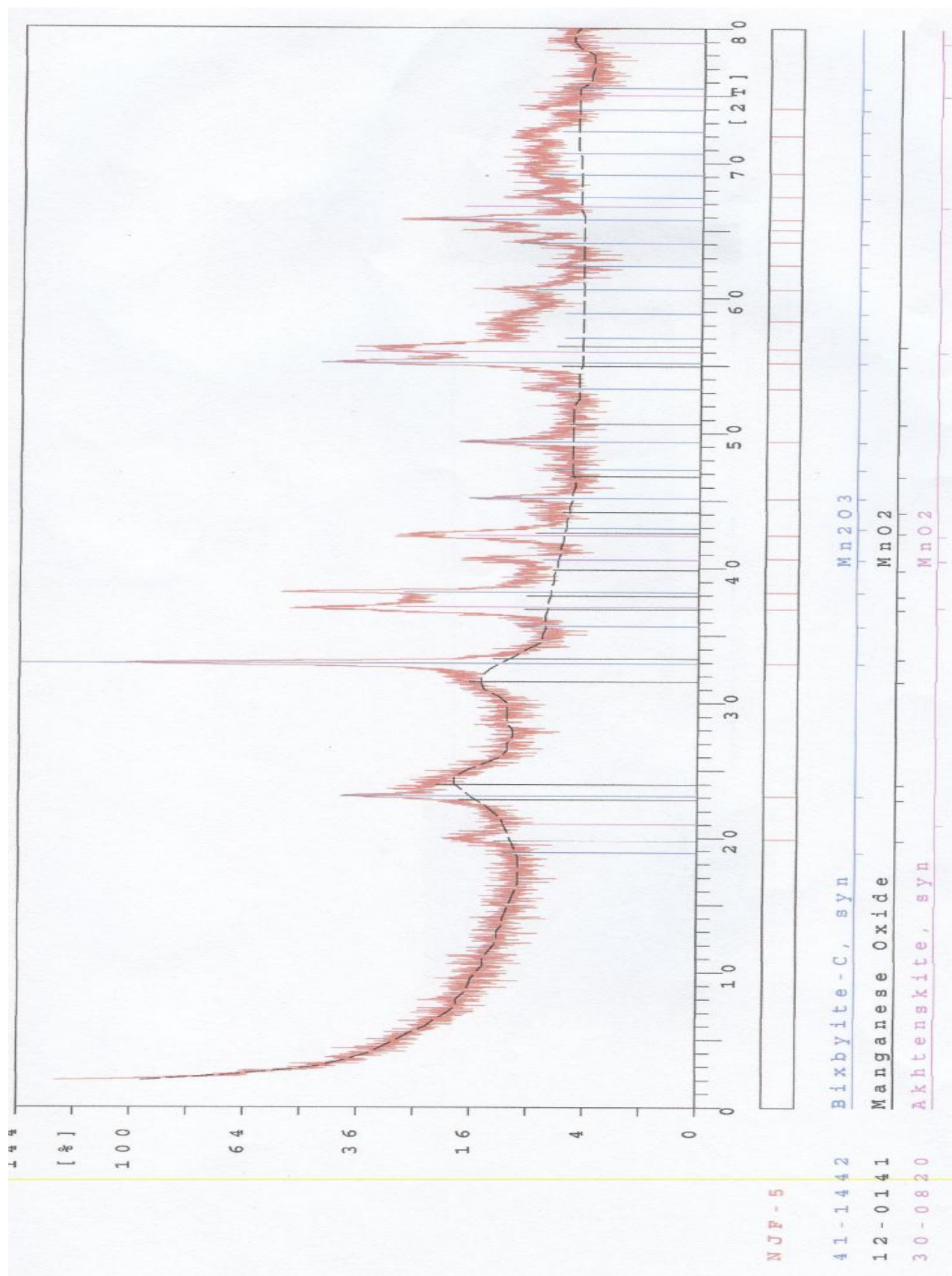
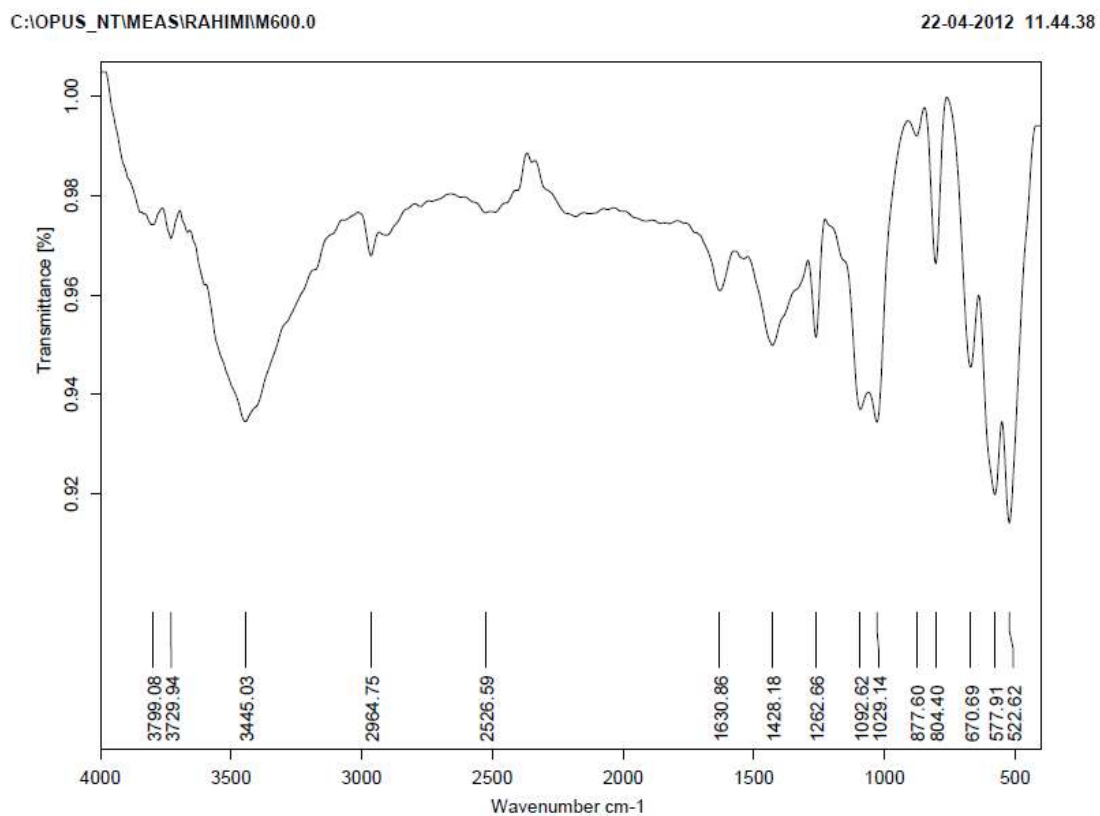
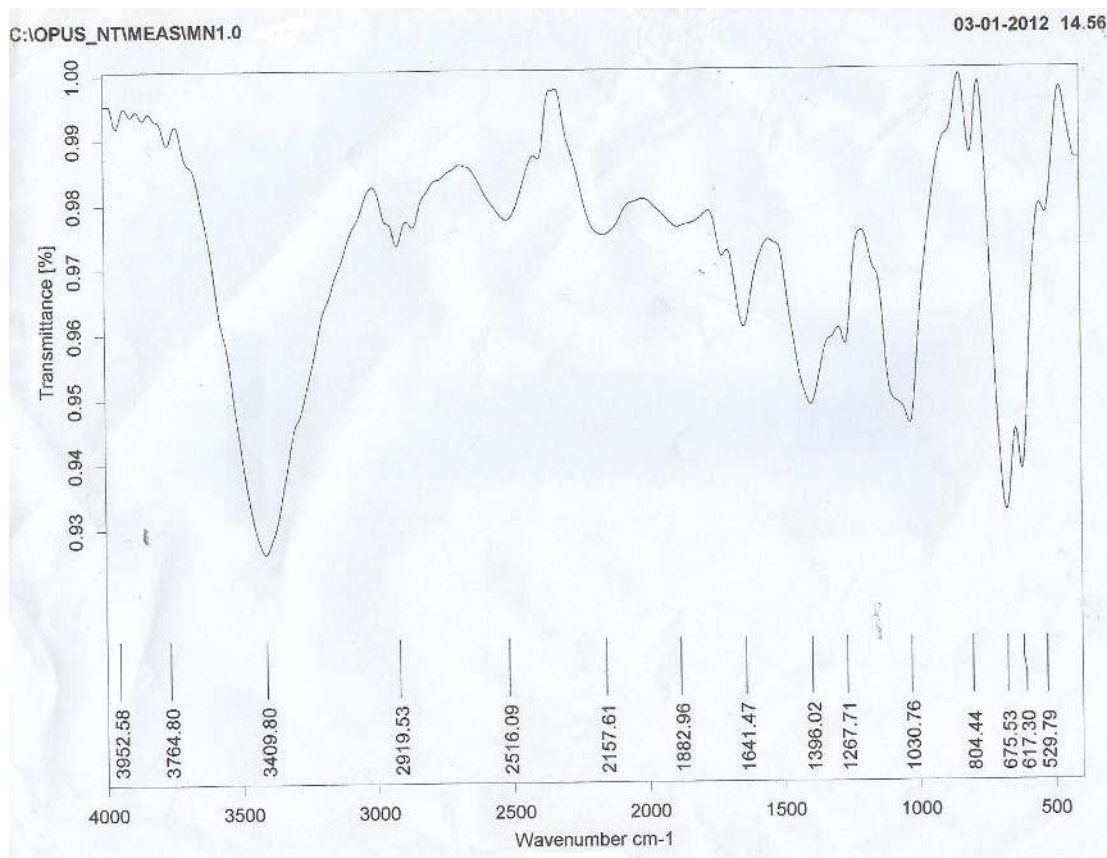
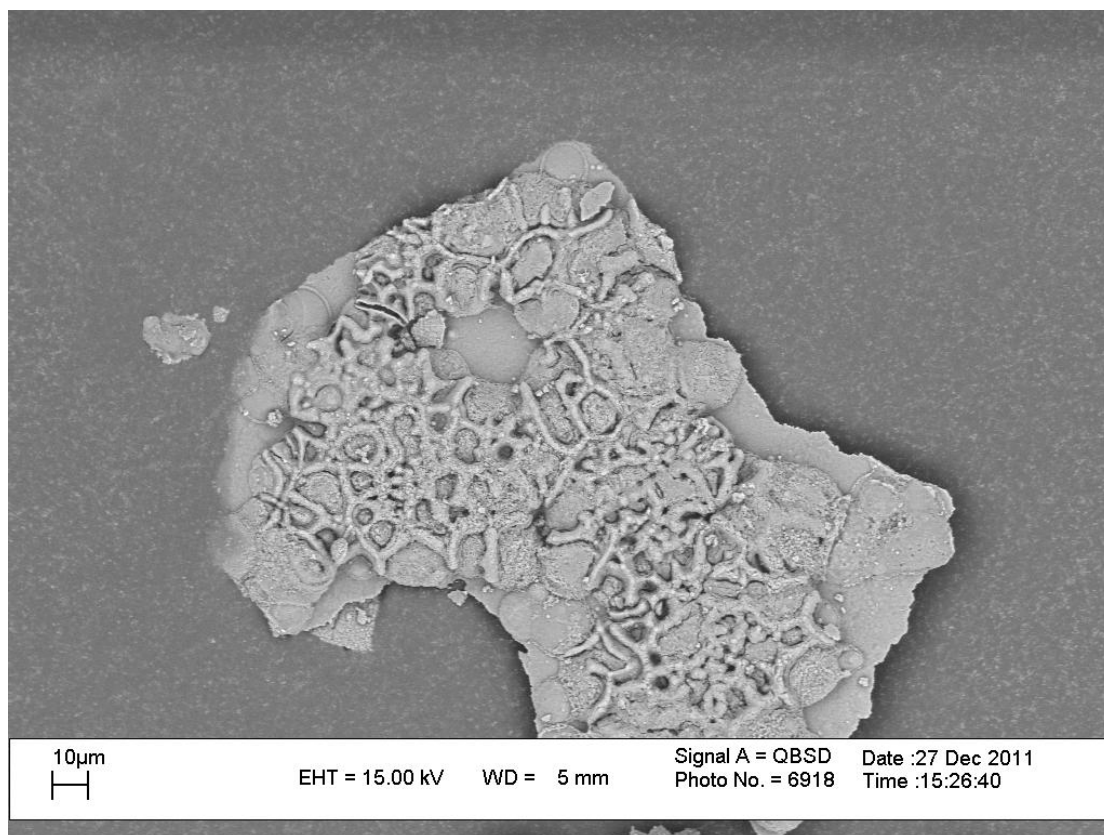


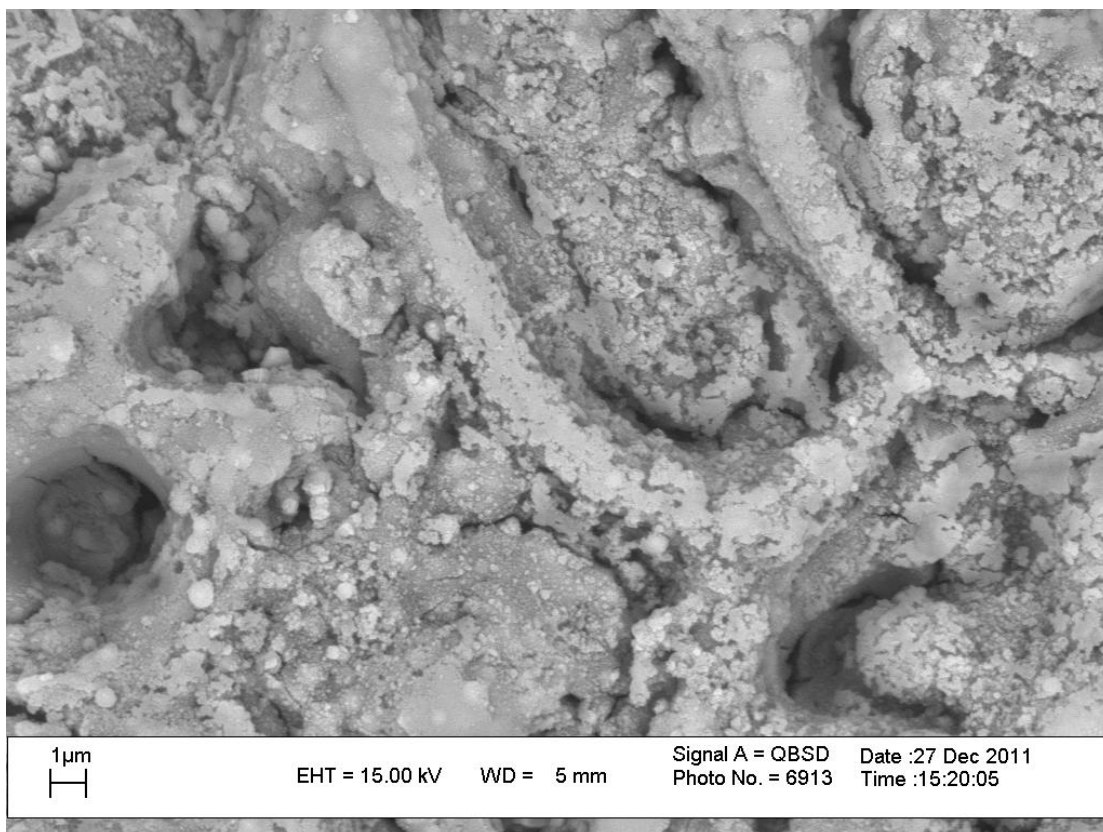
Fig. S2 XRD patterns of the obtained the nano-sized manganese oxide.



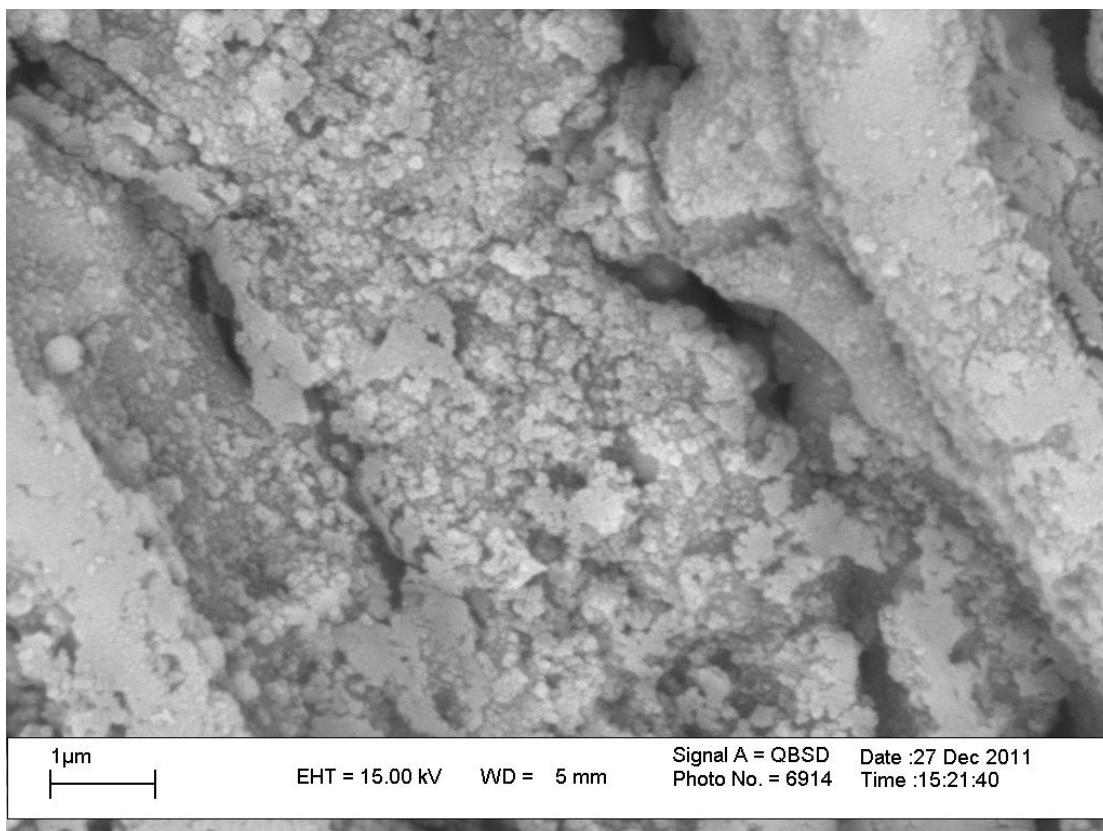
(b)
Fig. S3 IR spectra of sample calcined at 100 (top), and 600 °C (bottom)



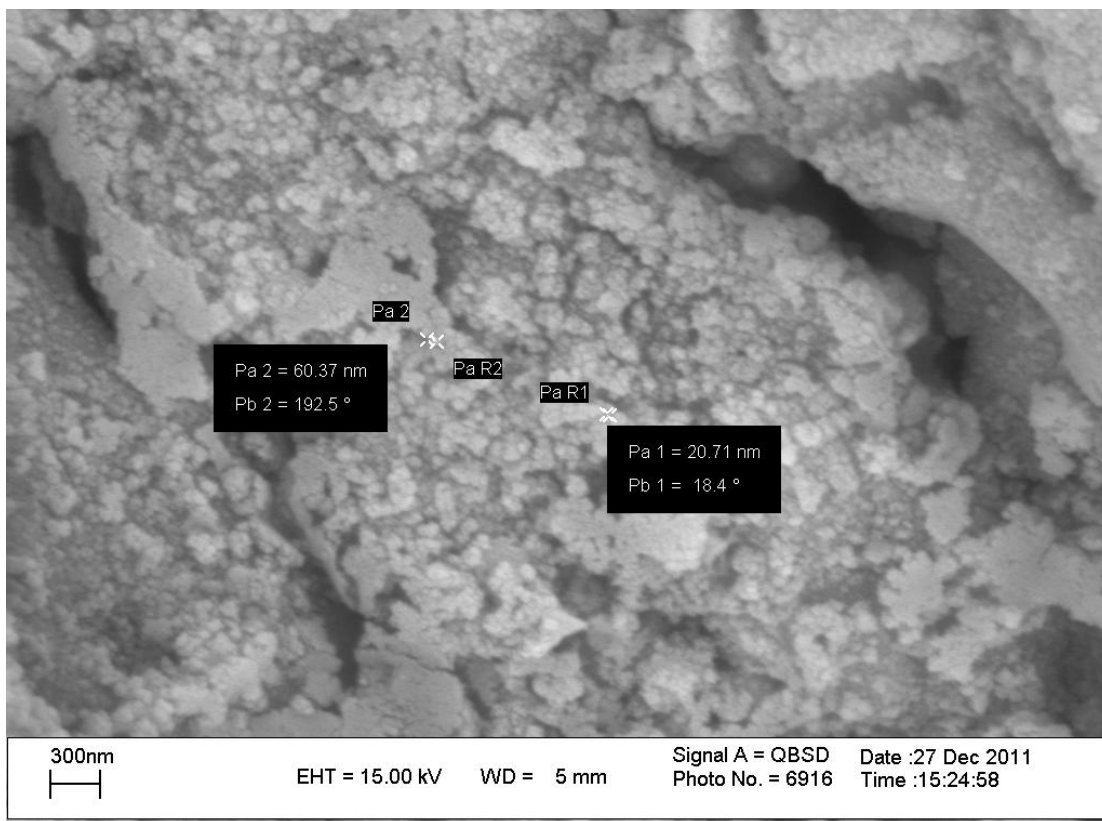
(a)



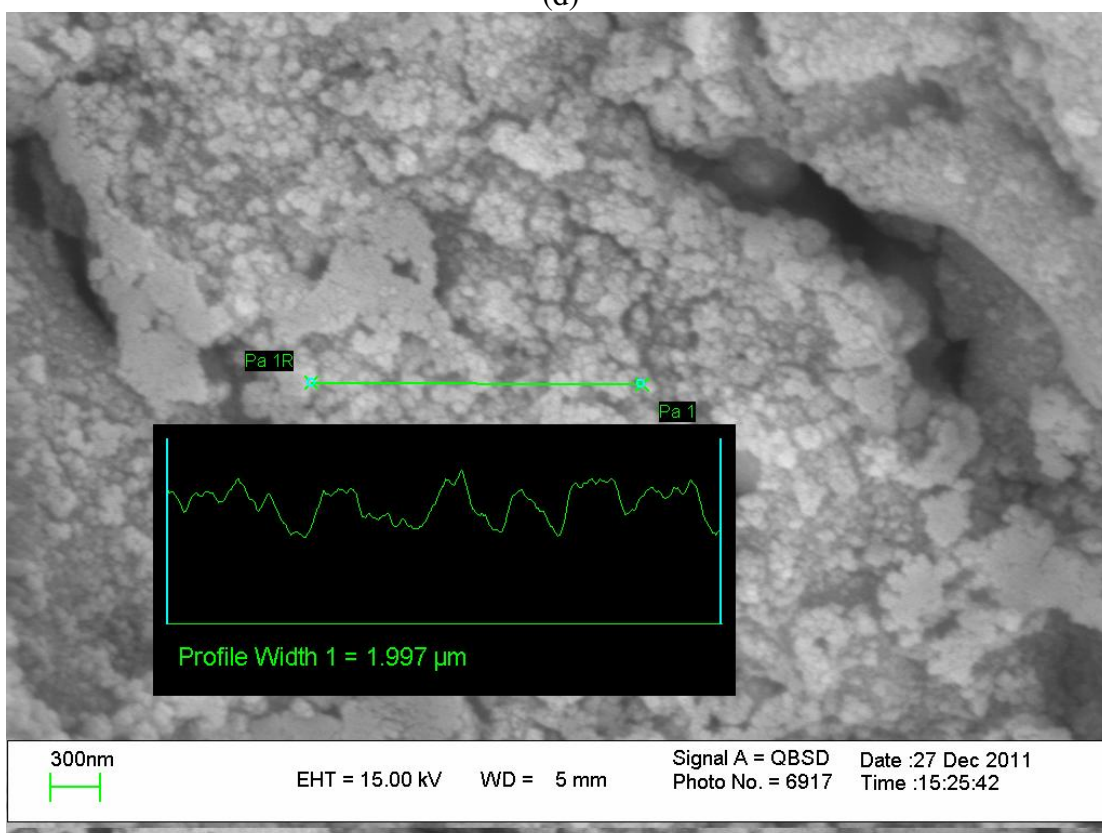
(b)



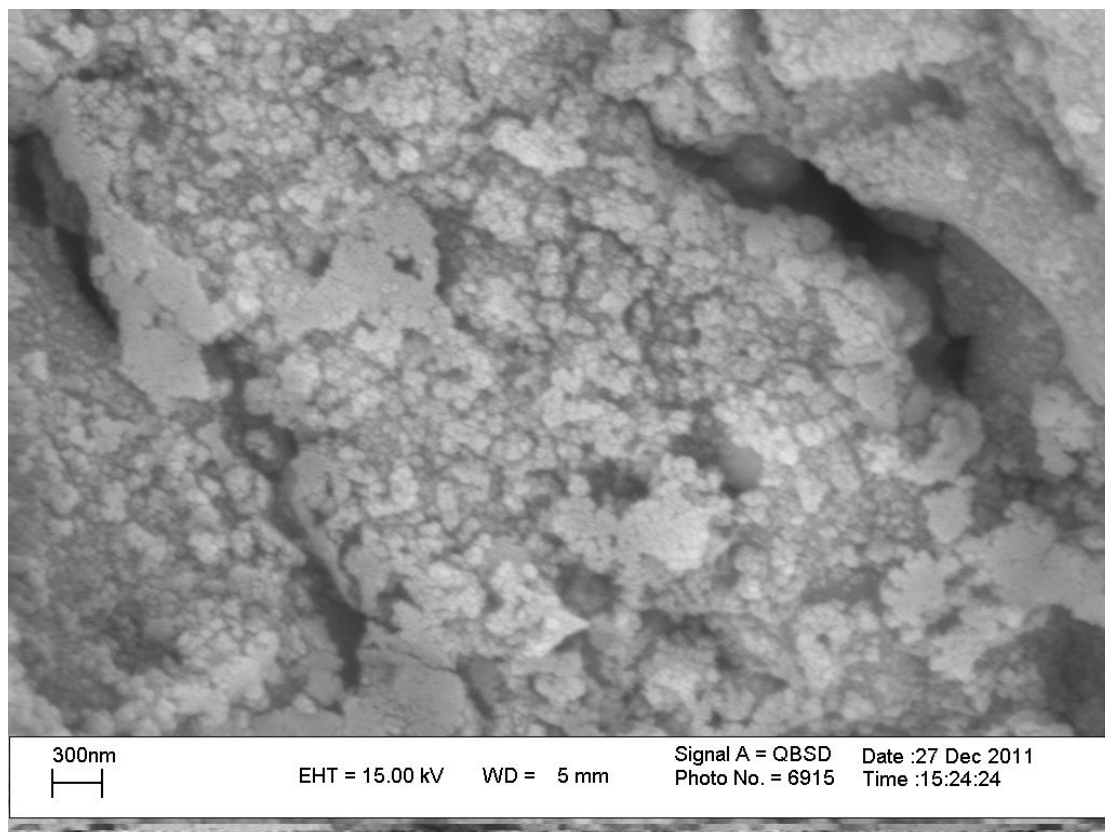
(c)



(d)



(e)

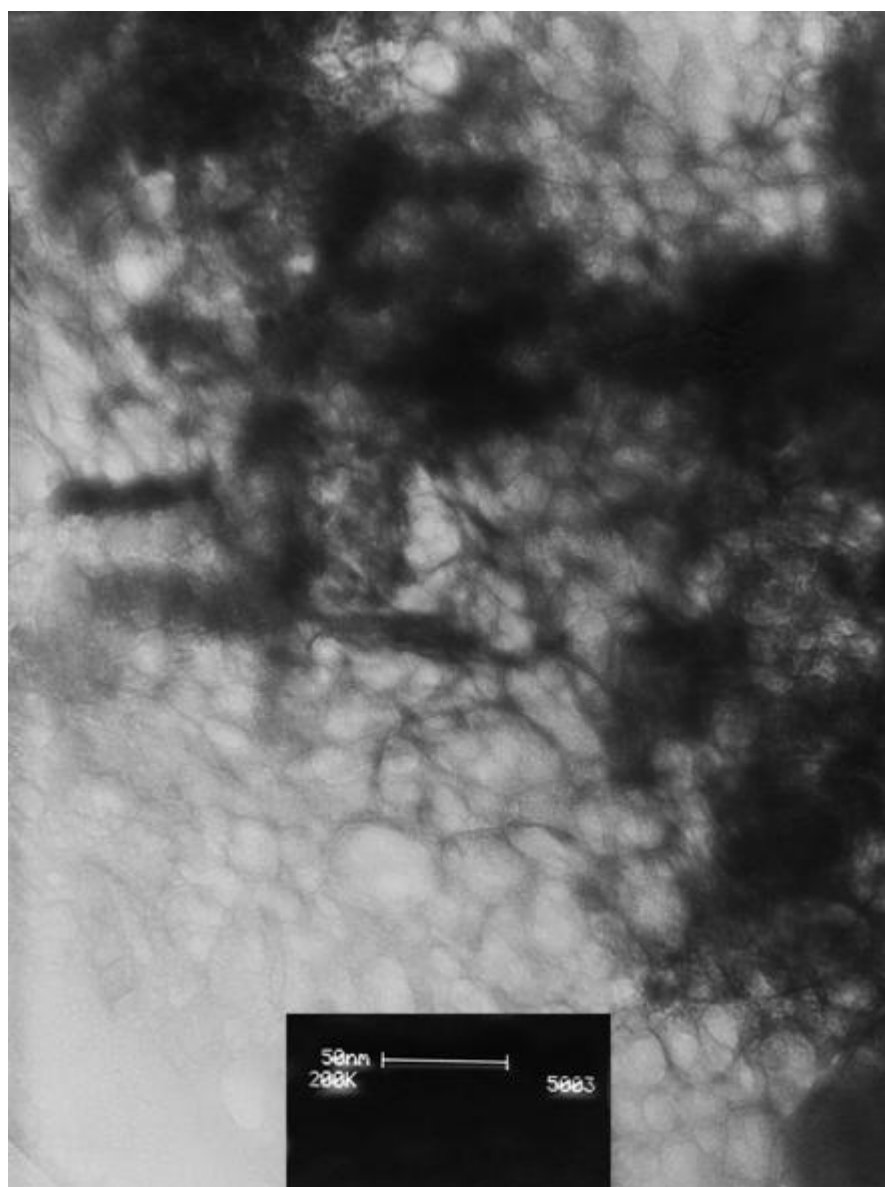


(f)

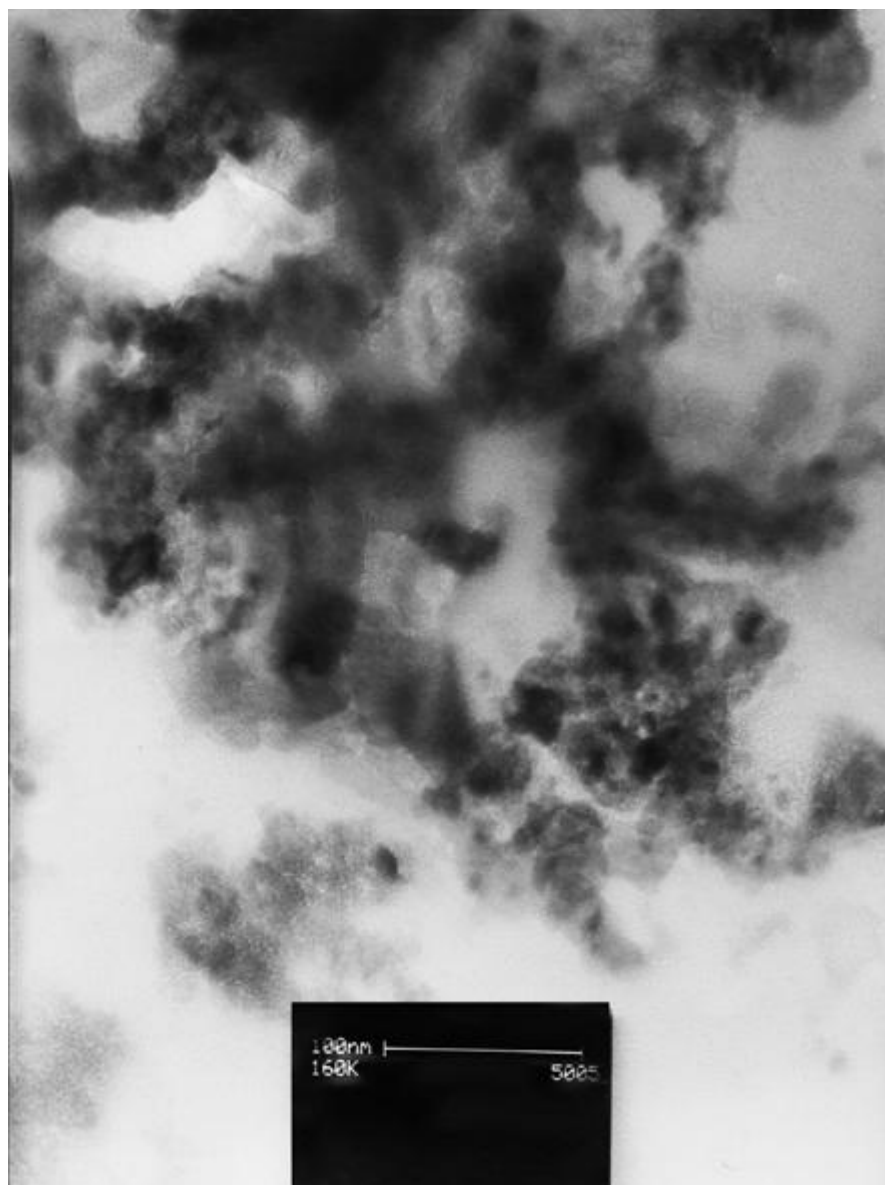
Fig. S4 SEM images of nano-sized manganese oxide (a-f).



(a)



(b)



(c)



(d)

Fig. S5 TEM images of zinc - manganese oxides prepared at 300 °C (a-d).

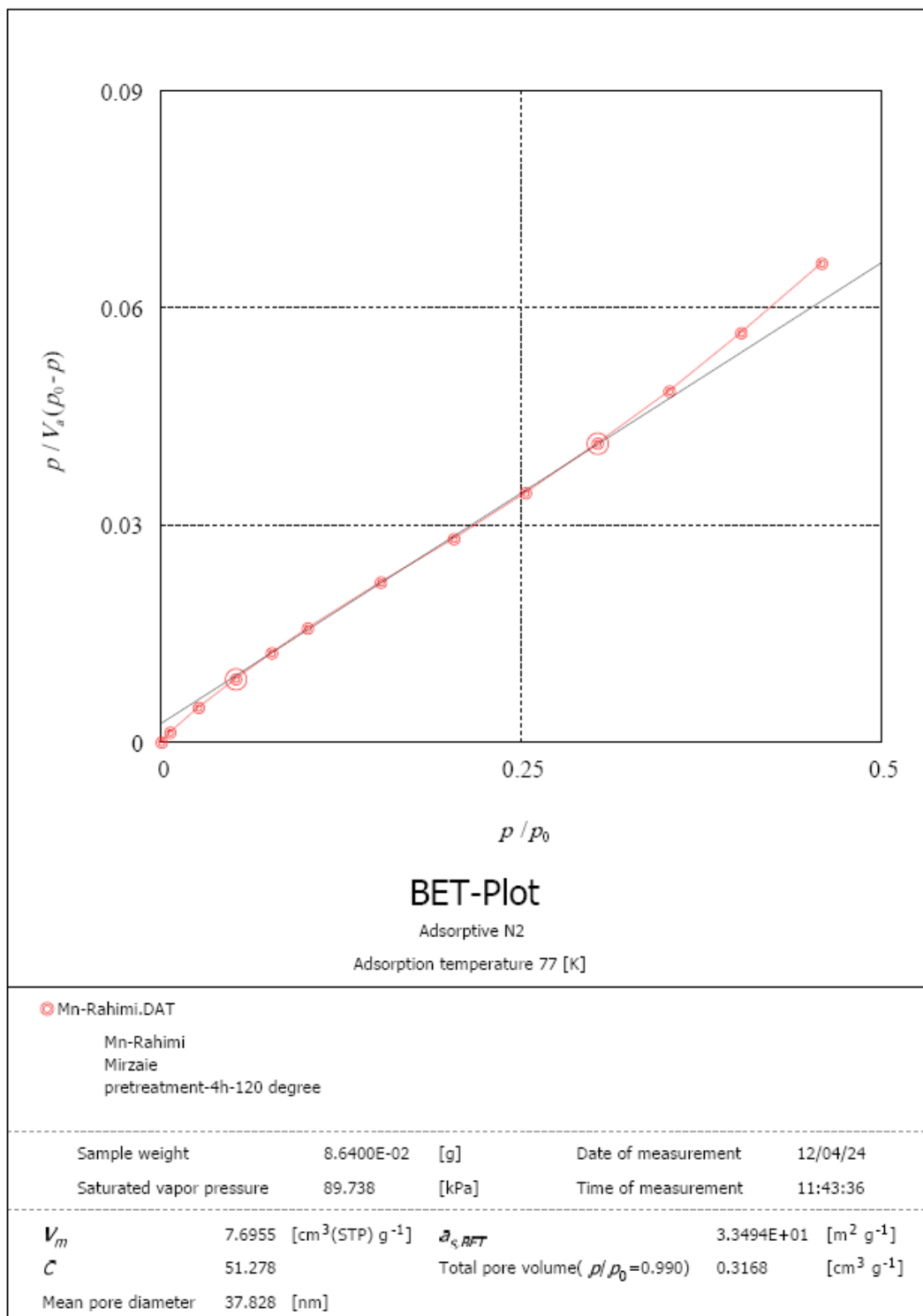


Fig. S6 The BET plot for prepared sample.

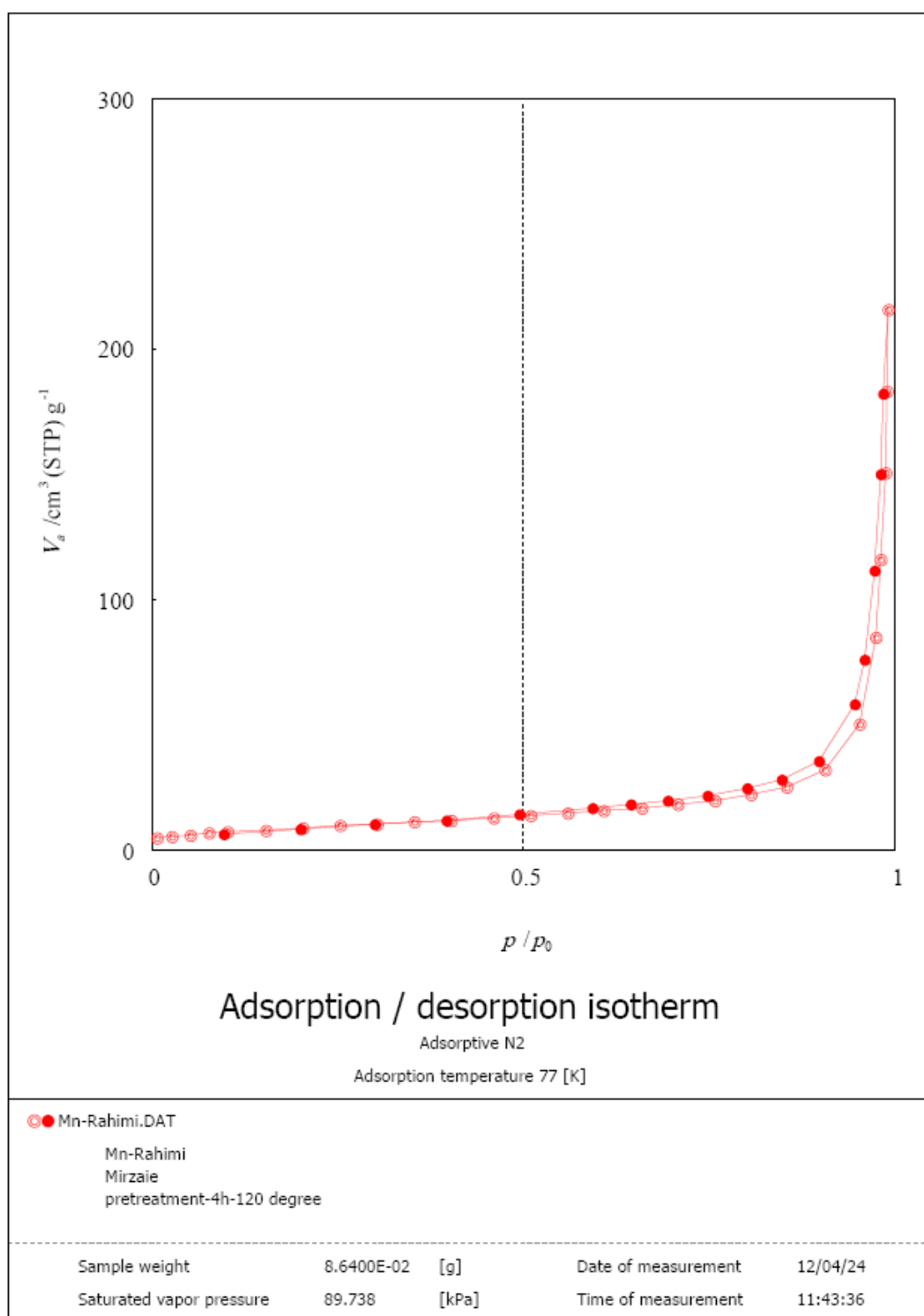
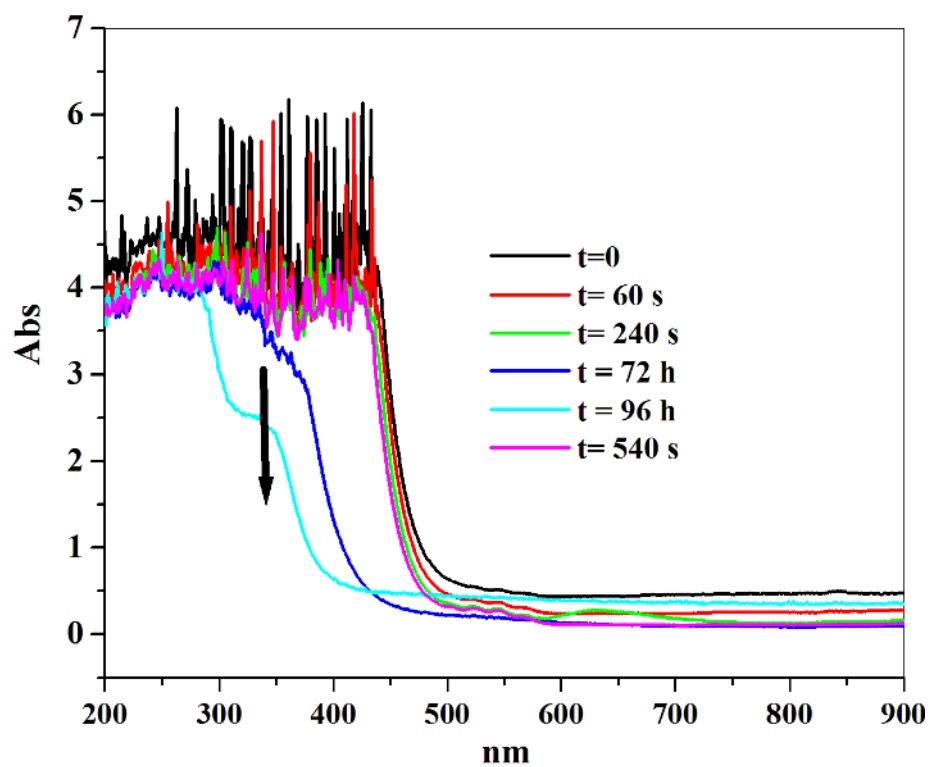
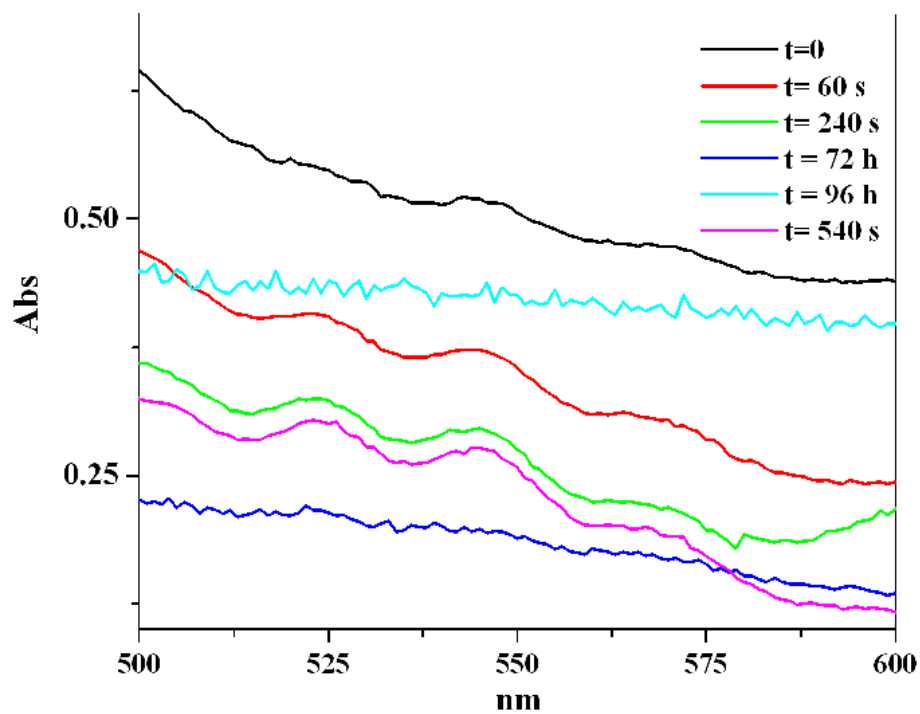


Fig. S7 The Adsorption / desorption isotherm plot for prepared sample.



(a)



(b)

Fig. S8 UV-vis spectra of the catalyst (10.0 mg) in Ce(IV) (0.4 M). The reduction of Ce(IV) (top) and MnO_4^- formation (bottom) could be observed in the first hours.

Table S1 The rate of water oxidation by the various manganese oxides as catalysts for water oxidation.

Compound	Oxidant	TOF ^a	References
Nano-sized manganese oxide	Ce(IV)	0.15	This work
Octahedral Molecular Sieves	Ru(bpy) ₃ ³⁺	0.11	1
	Ce(IV)	0.05	
Octahedral Layered	Ru(bpy) ₃ ³⁺	0.028	1
	Ce(IV)	0.0047	
Amorphous Manganese Oxides	Ru(bpy) ₃ ³⁺	0.06	1
	Ce(IV)	0.52	
CaMnO ₃	Ce(IV)	0.012	2
Ca ₂ Mn ₃ O ₈	Ce(IV)	0.016	2
CaMn ₂ O ₄ .H ₂ O (Nano particles)	Ce(IV)	2.2	3
CaMn ₃ O ₆	Ce(IV)	0.046	4
CaMn ₄ O ₈	Ce(IV)	0.035	4
CaMn ₂ O ₄ .4H ₂ O	Ce(IV)	0.32	5
CaMn ₂ O ₄ .H ₂ O	Ce(IV)	0.54	5
Mn ₂ O ₃	Ce(IV)	0.027	5
α-MnO ₂ nanotubes	Ru(bpy) ₃ ³⁺	0.035	6
α-MnO ₂ nanowires	Ru(bpy) ₃ ³⁺	0.059	6
β-MnO ₂ nanowires	Ru(bpy) ₃ ³⁺	0.02	6
Bulk α-MnO ₂	Ru(bpy) ₃ ³⁺	0.01	6
Mn oxide nanoclusters	Ru(bpy) ₃ ³⁺	0.28	7
MnO ₂ (colloid)	Ce(IV)	0.09	8
PSII	Sunlight	25000	9

^a mmol O₂/mol Mn per second. In these calculations, it is assumed that all deposited metal centers are involved in the catalysis, so lower TOF limits are calculated.

References:

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