Support Information

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

Mohammad Mahdi Najafpour[*1,2], Fahimeh Rahimi[1], Mojtaba Amini[*3], Sara Nayeri[1] and Mojtaba Bagherzadeh[4]

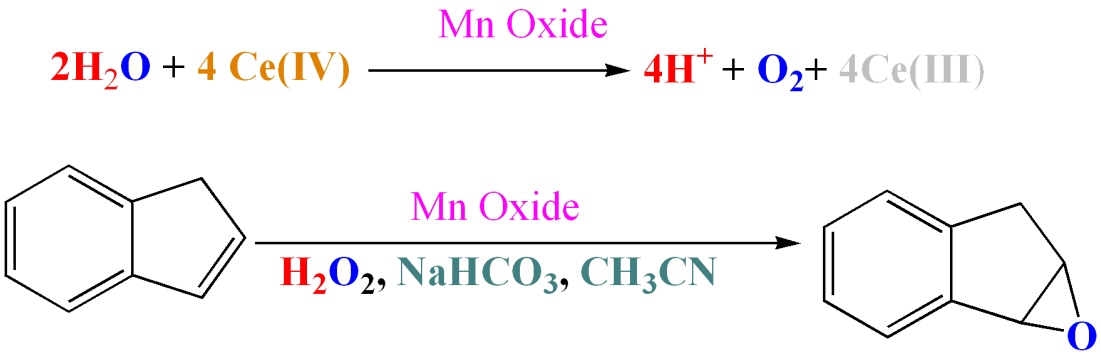
[1] *Department of Chemistry, Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, 45137-66731, Iran*

[2] *Center of Climate Change and Global Warming, Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, 45137-66731, Iran*

[3] *Department of Chemistry, Faculty of Science, University of Maragheh, Golshahr, P.O. Box: 55181-83111731, Maragheh, Iran*

[4] *Chemistry Department, Sharif University of Technology, PO Box 11155-3516, Tehran, Iran*

Corresponding authors; Phone: (+98) 241 415 3201; E-mail: mmnajafpour@iasbs.ac.ir (MMN); Phone: (+98) 421 2278900; E-mail: mamini@maragheh.ac.ir (MA).



Scheme S1. Chemical equations for the studied reactions.

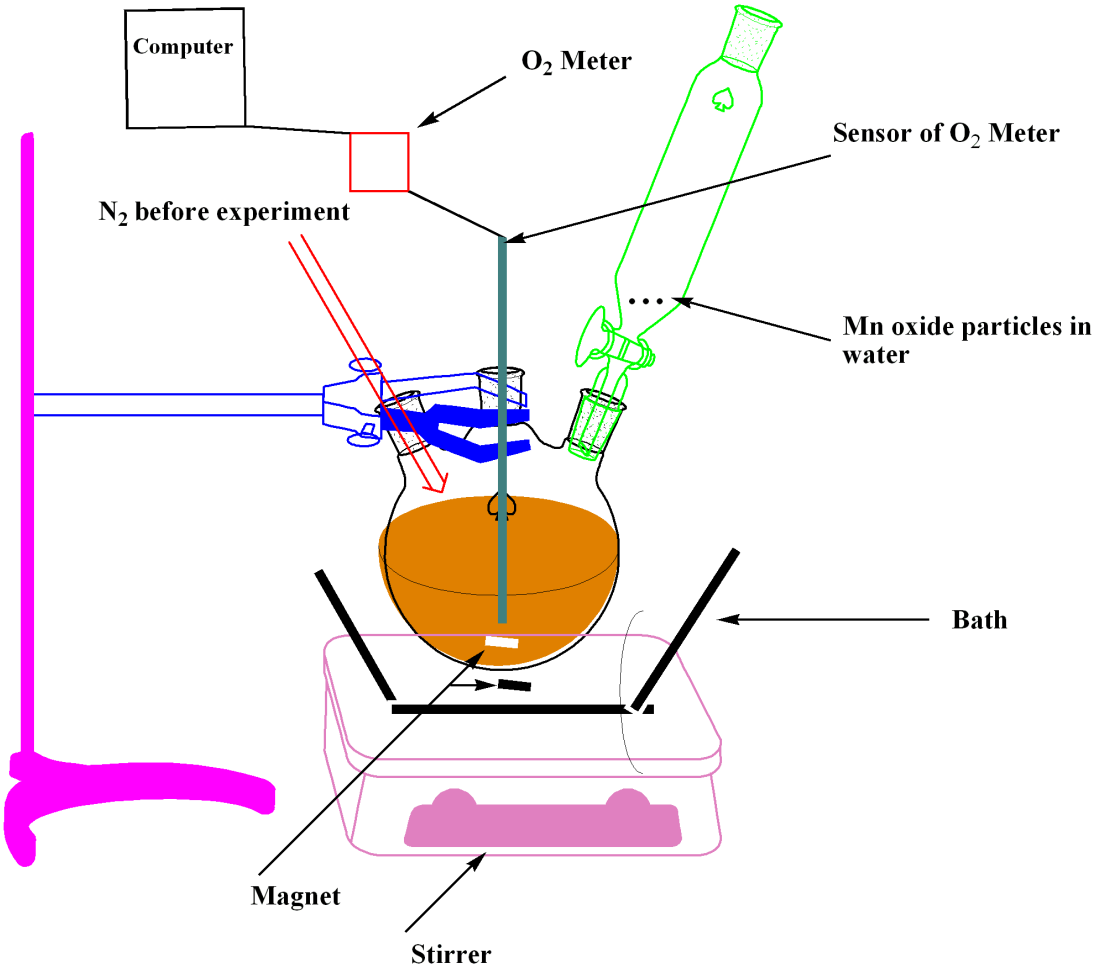


Fig. S1. The reactor set-up for oxygen evolution experiment in the presence of Ce(IV).

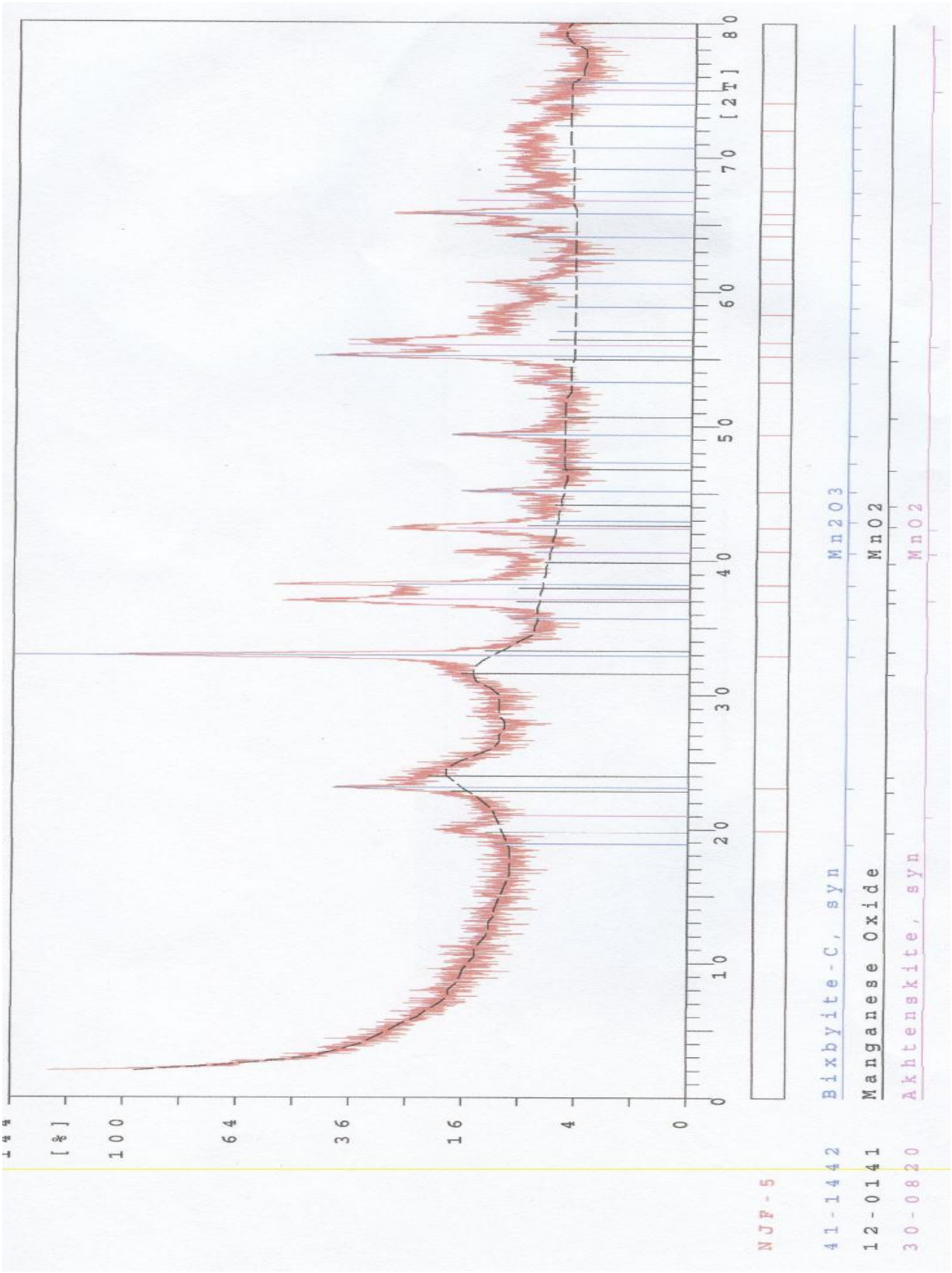
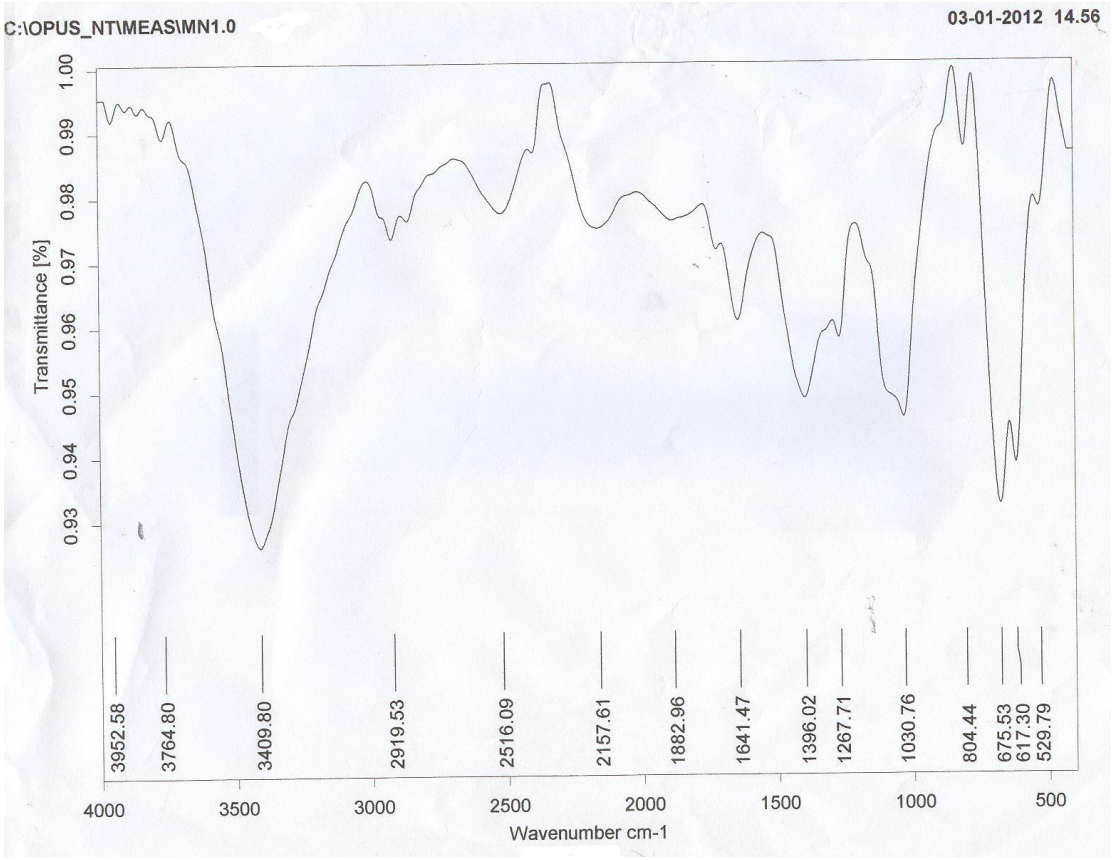


Fig. S2 XRD patterns of the obtained the nano-sized manganese oxide.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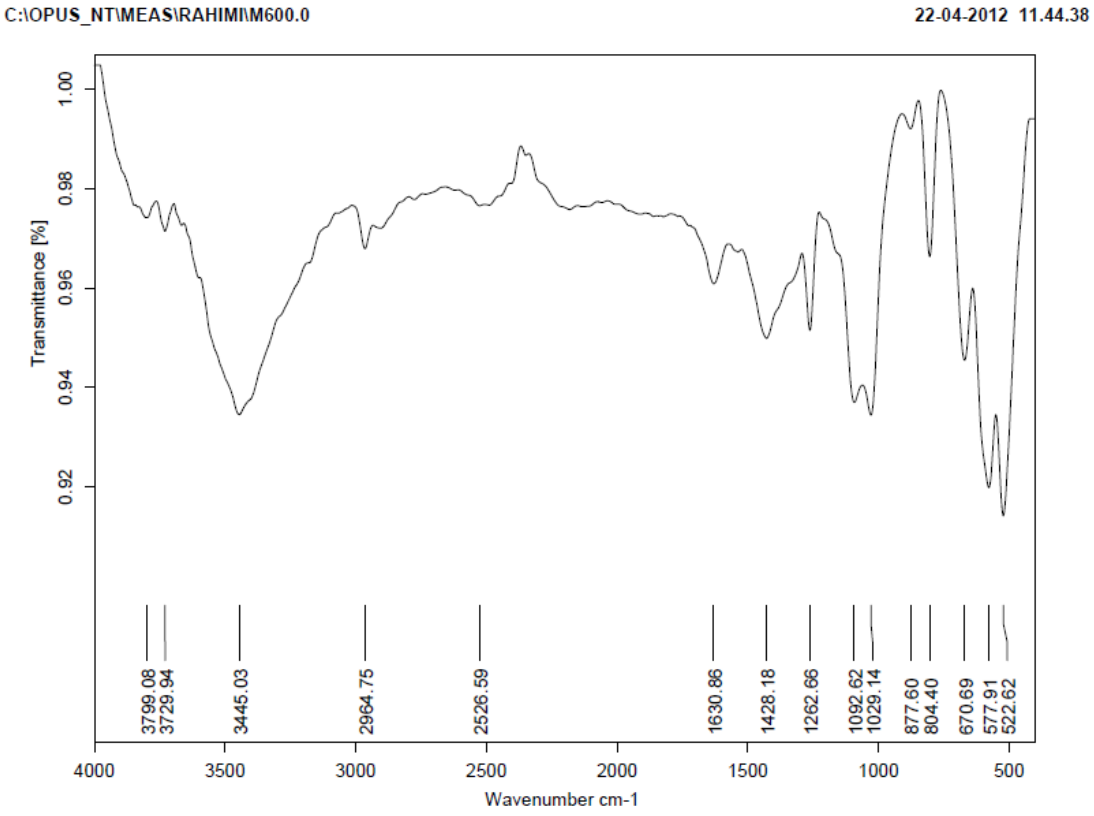
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577.91
522.62
4000
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3000
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1500
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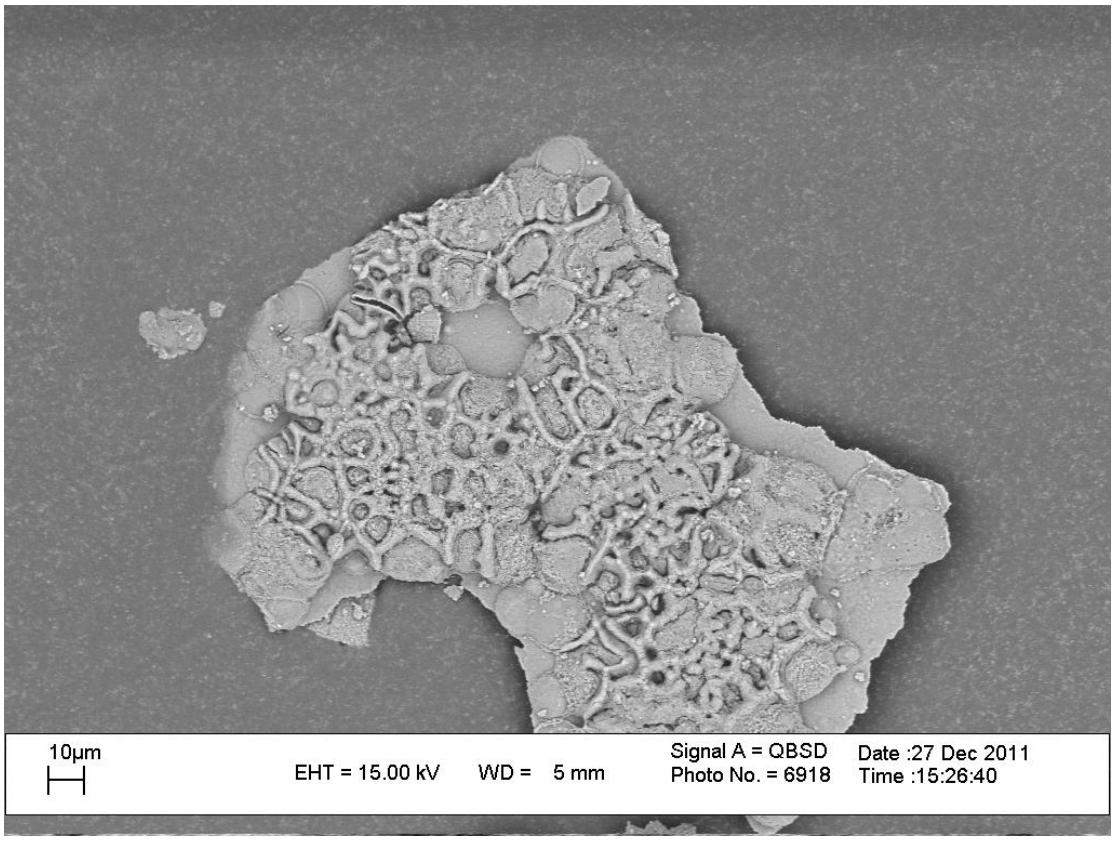
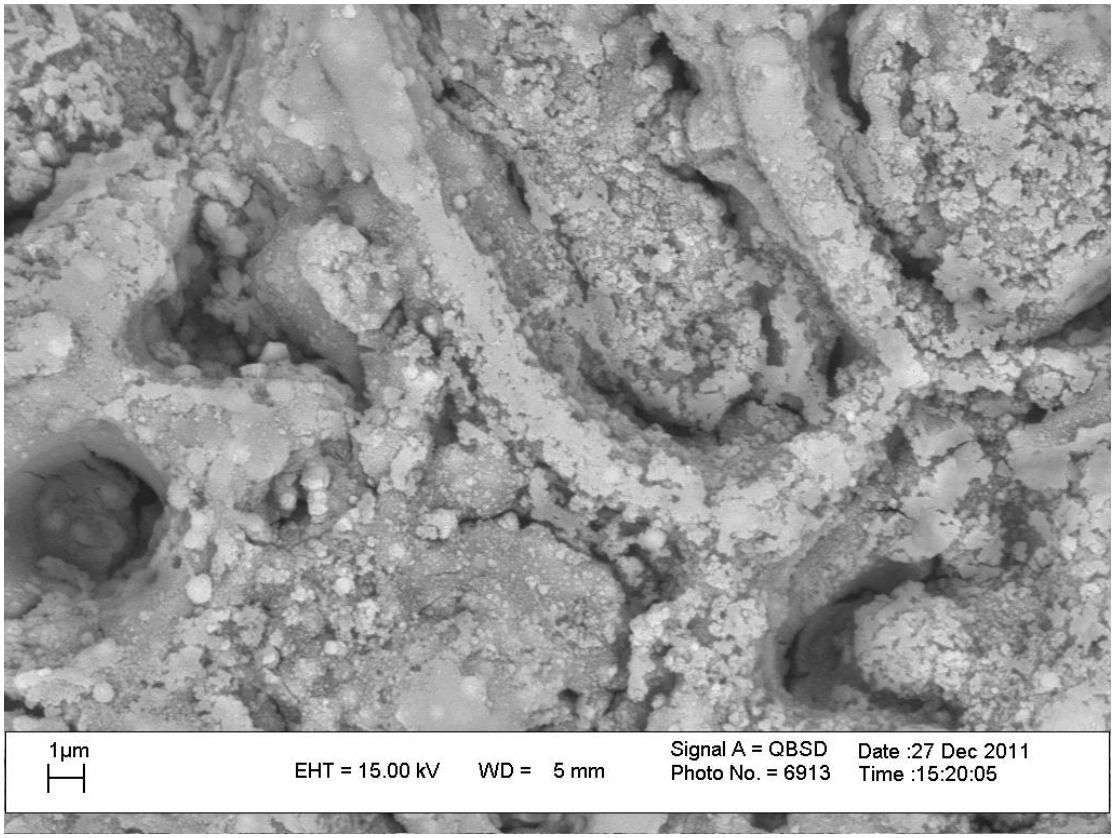
Wavenumber cm-1

(b)

Fig. S3 IR spectra of sample calcined at 100 (top), and 600 ^{o}C (bottom)



(a)



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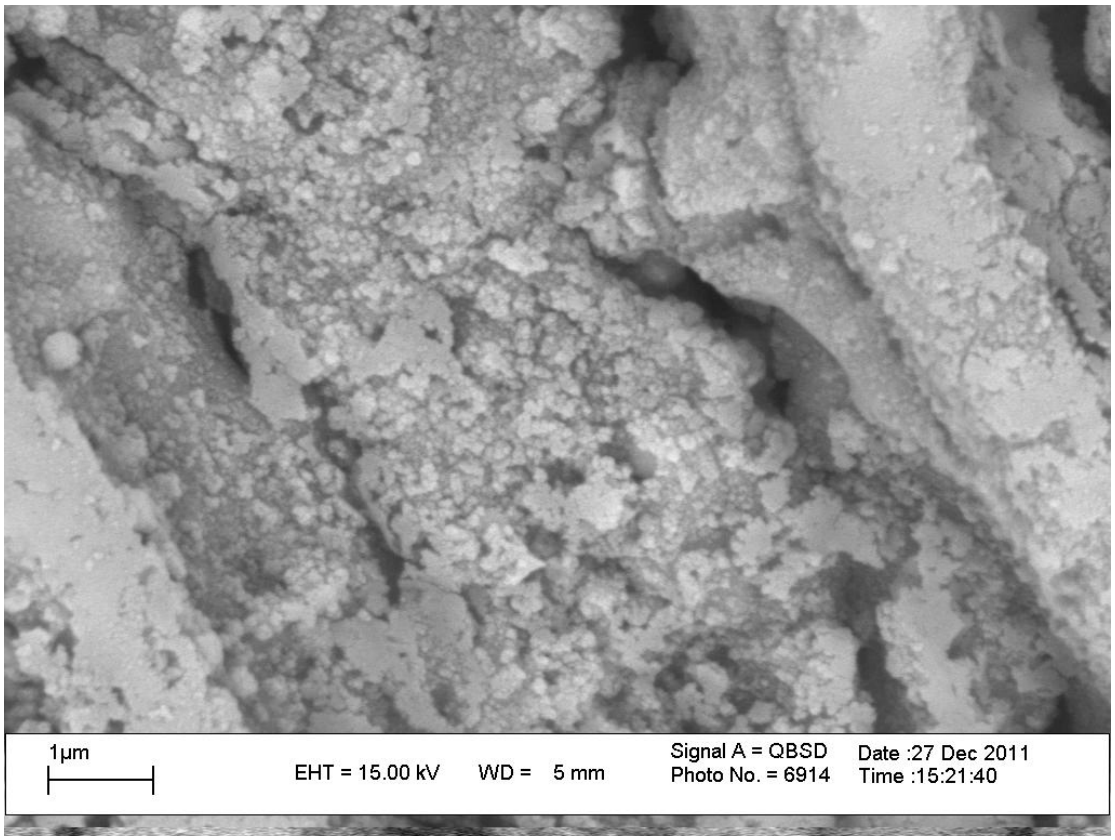
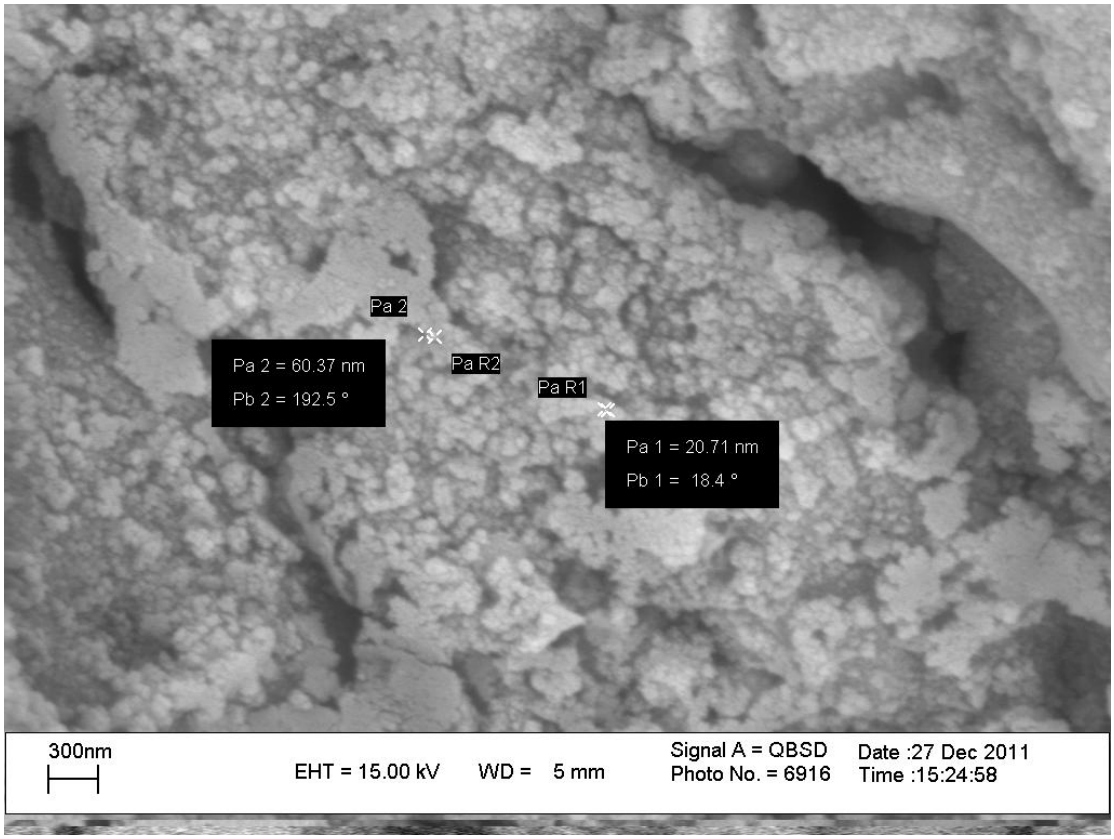
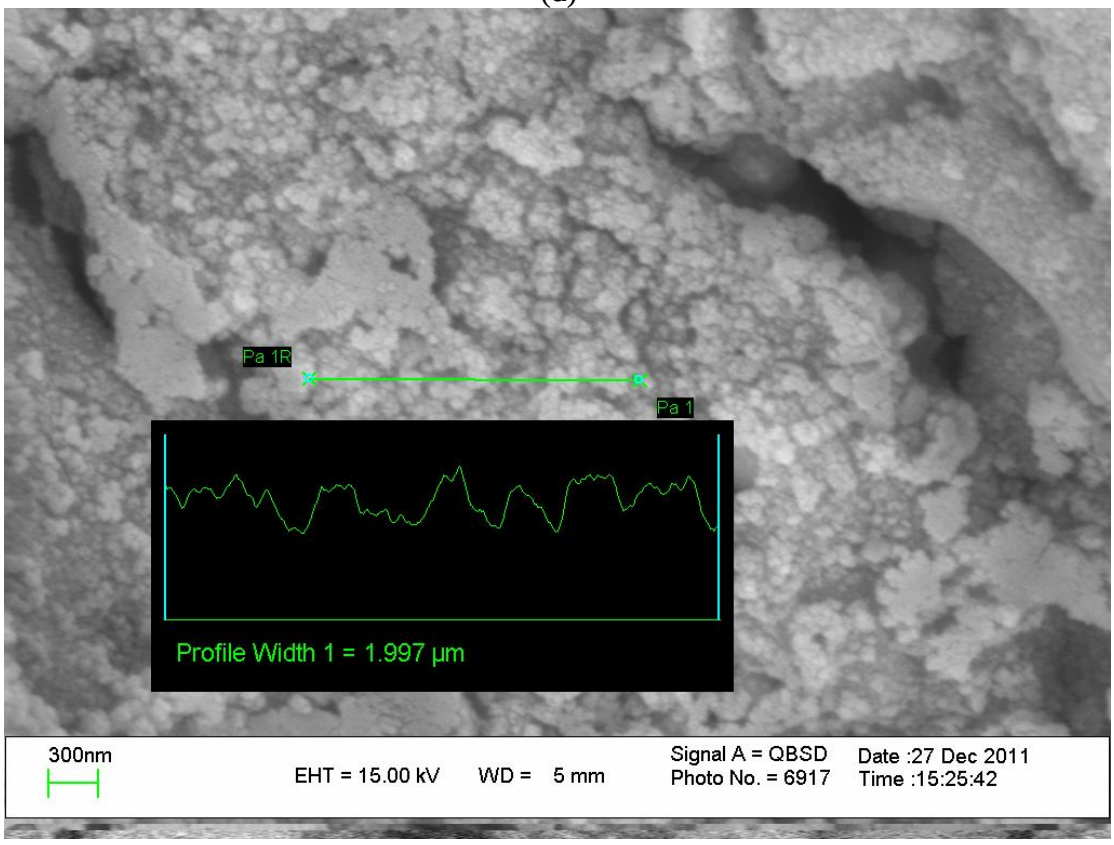


(c)



(d)



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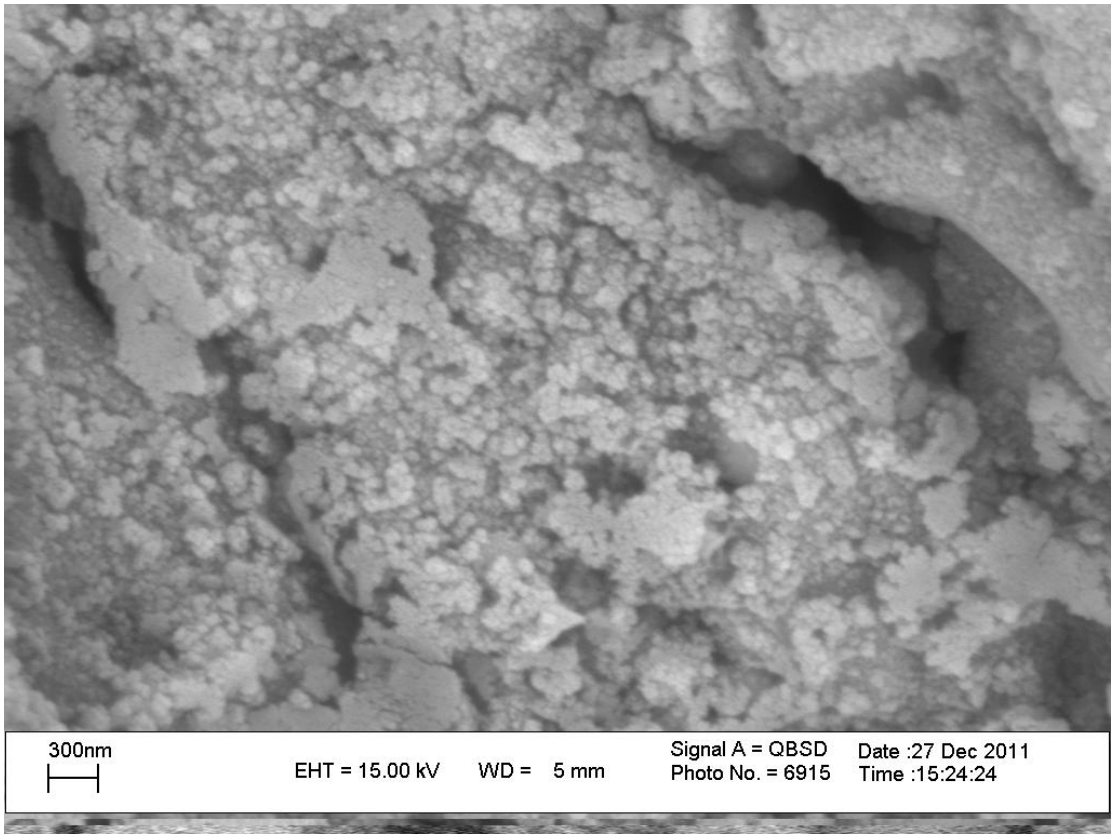
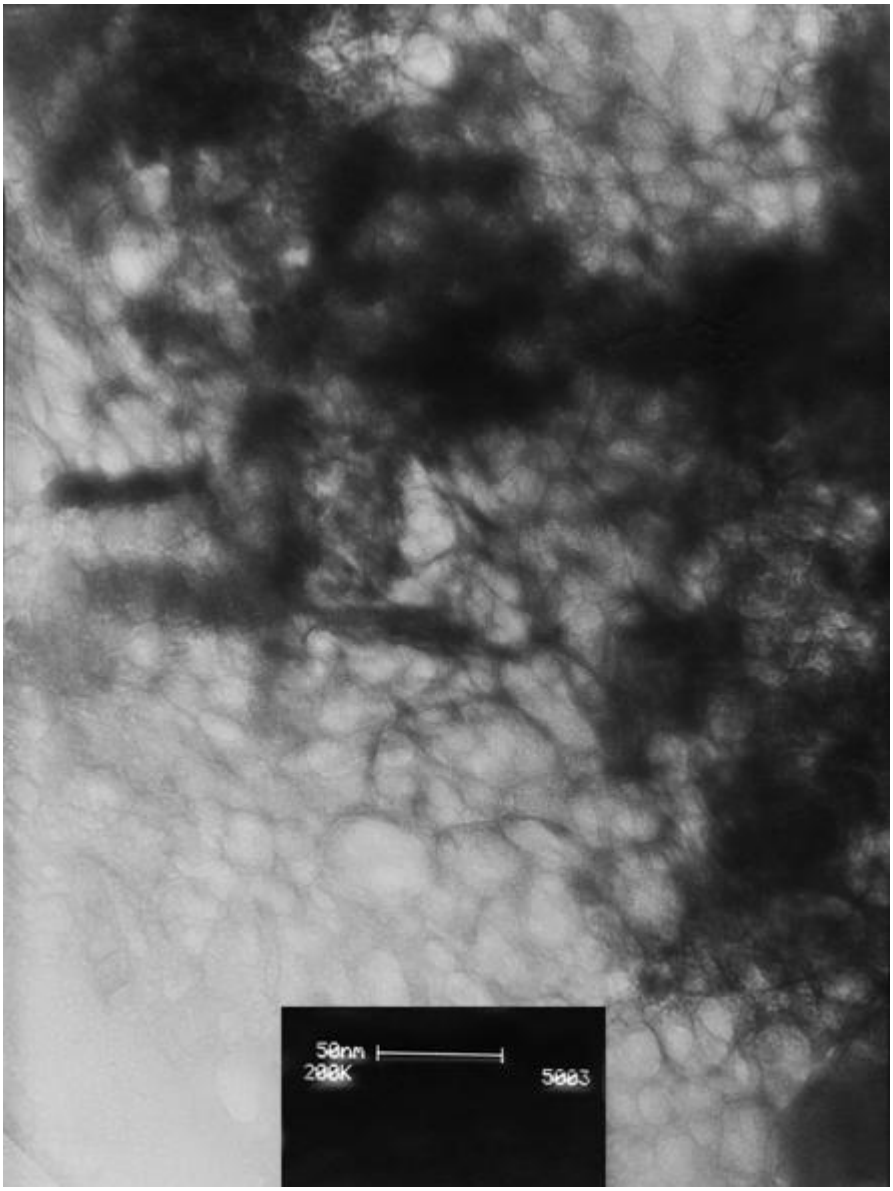


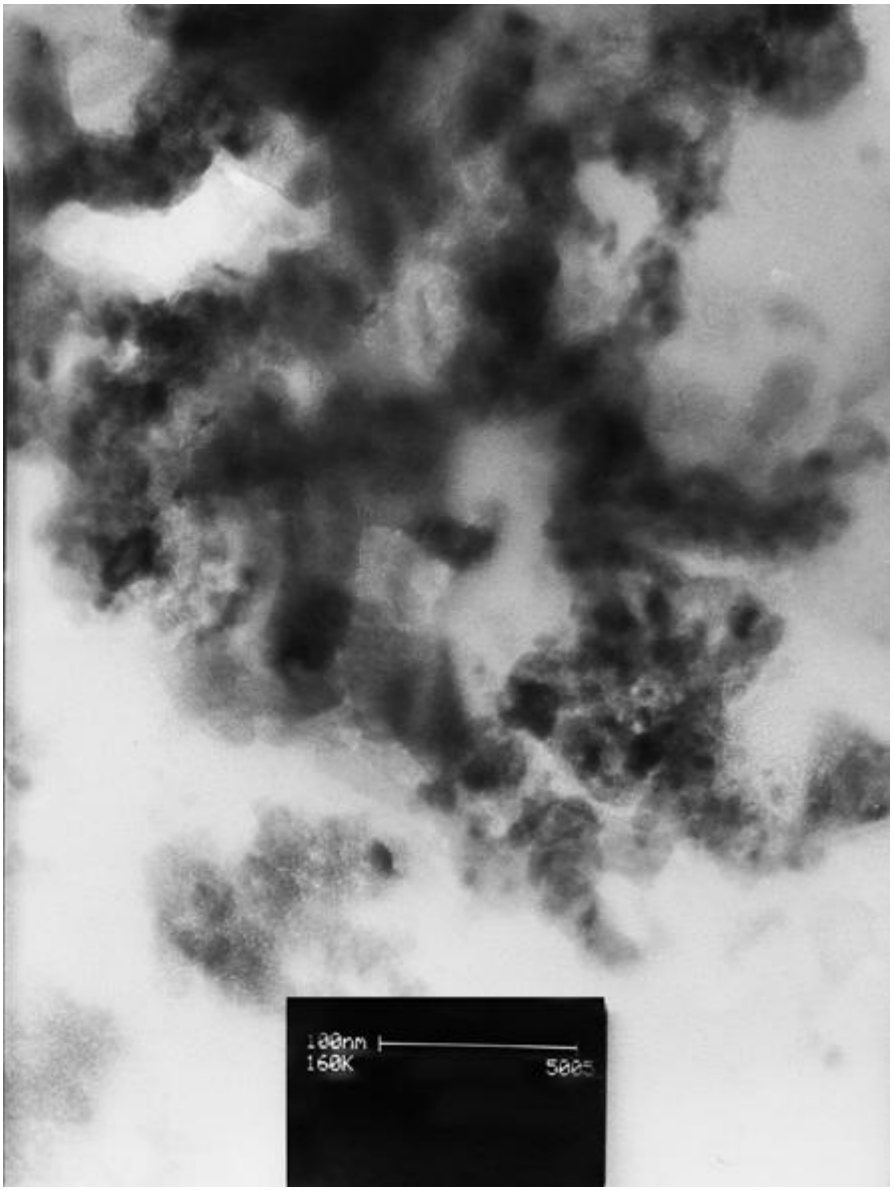
(f)

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

(a)



(b)



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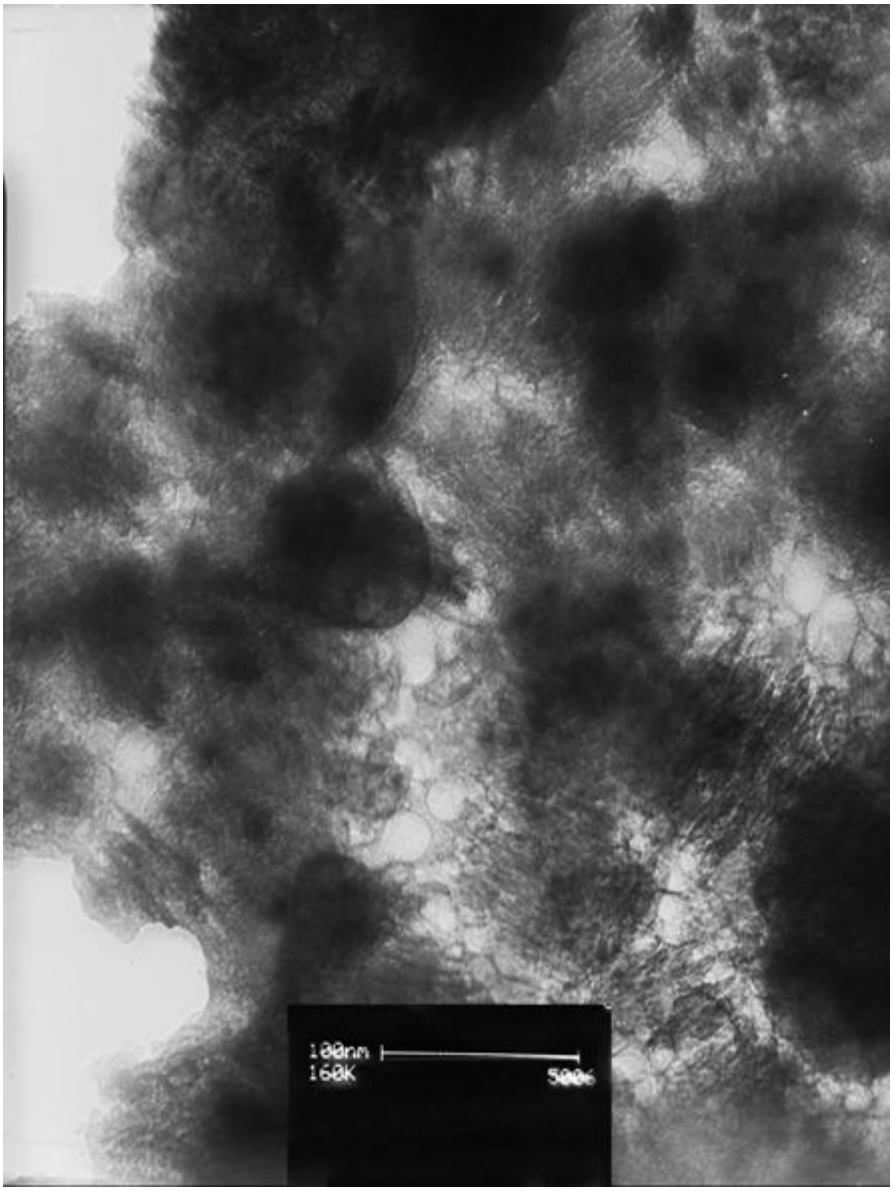


(d)

Fig. S5 TEM images of zinc - manganese oxides prepared at 300 ^{o}C (a-d).

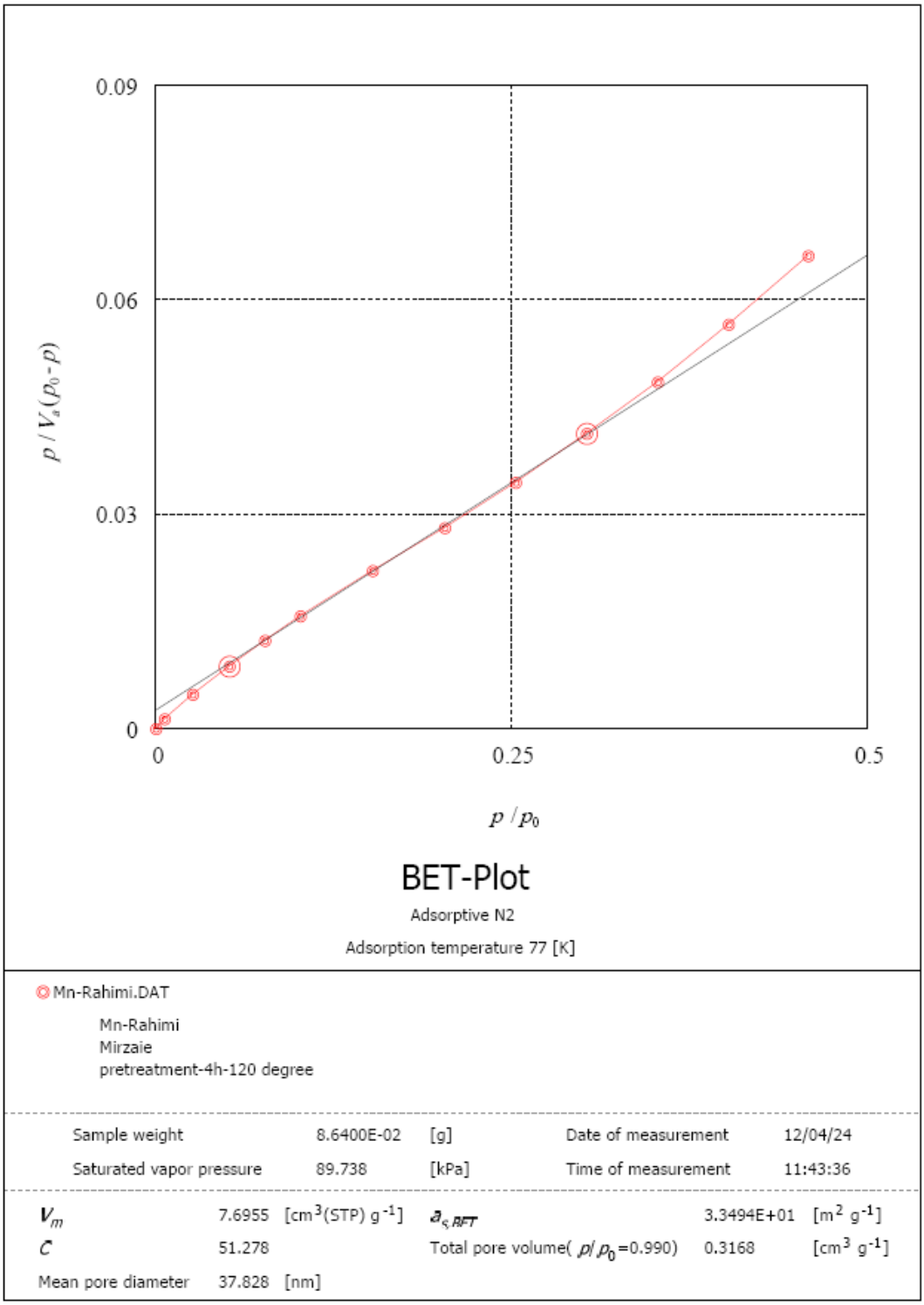


Fig. S6 The BET plot for prepared sample.

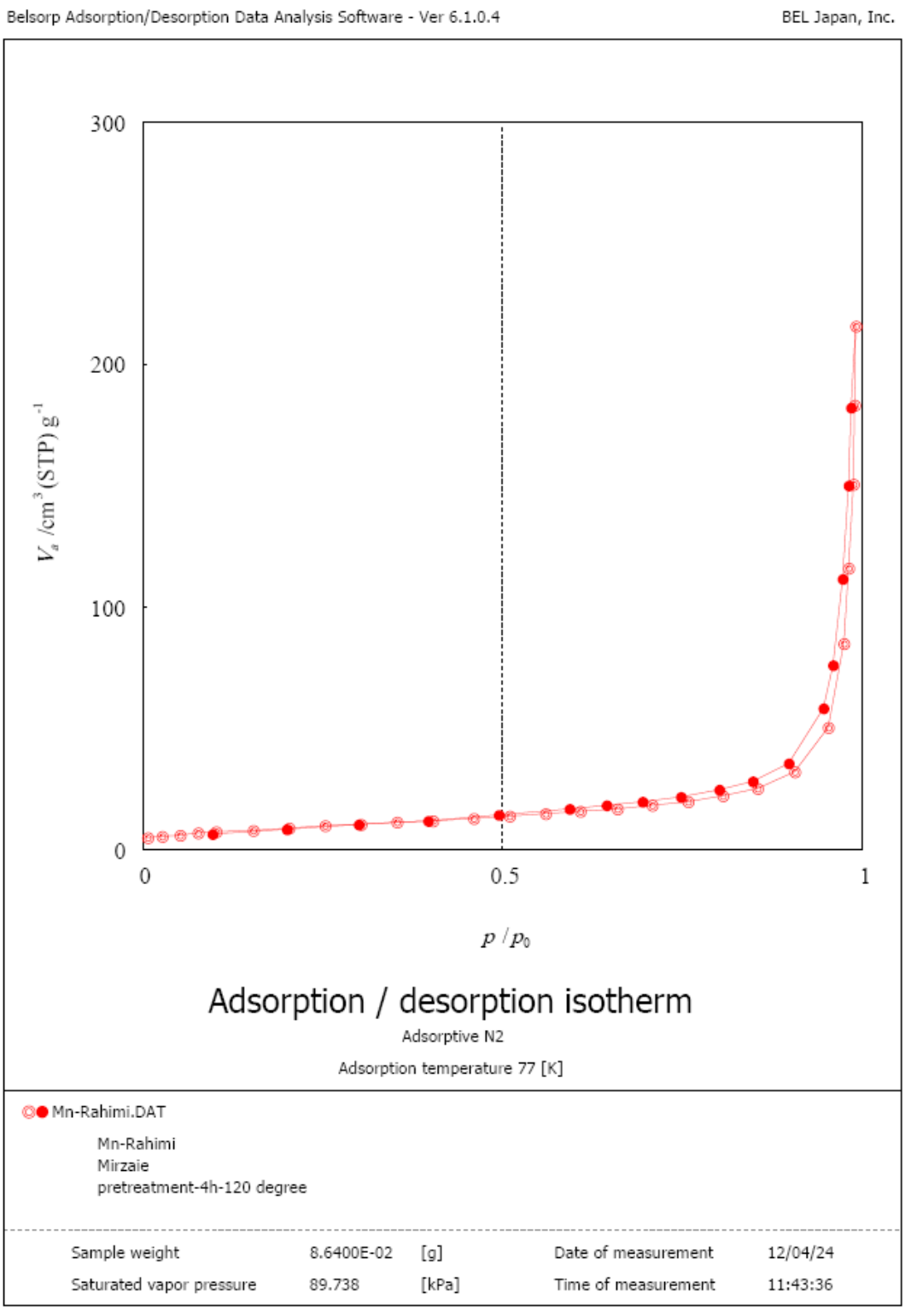
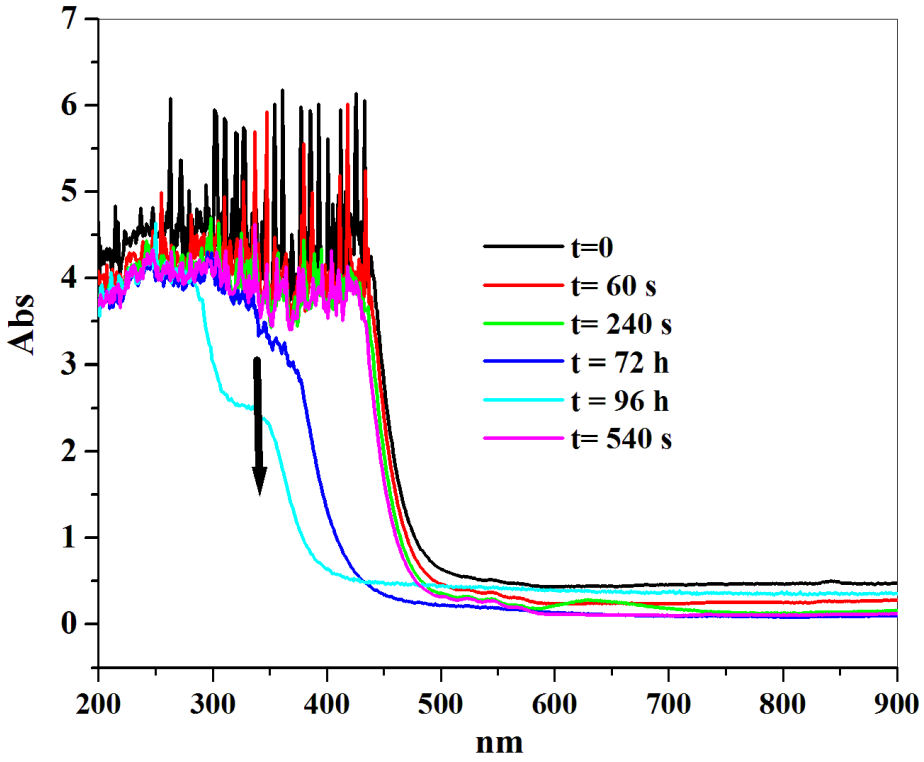
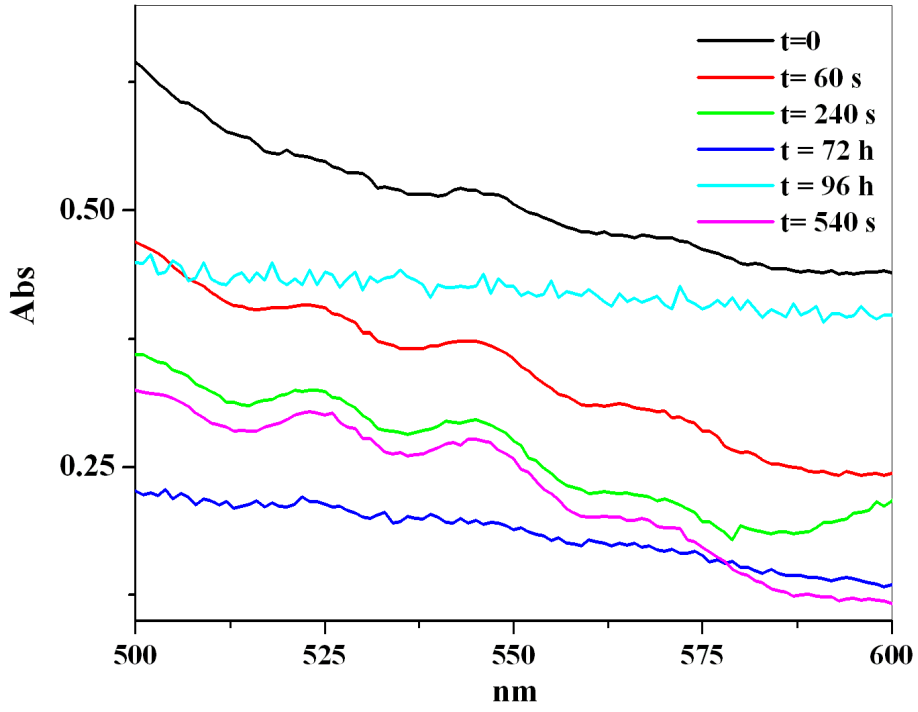


Fig. S7 The Adsorption / desorption isotherm plot for prepared sample.



(a)



(b)

Fig. S8 UV-vis specta 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
$Ca_2Mn_3O_8$	Ce(IV)	0.016	2
$CaMn_2O_4.H_2O$ (Nano particles)	Ce(IV)	2.2	3
$CaMn_3O_6$	Ce(IV)	0.046	4
$CaMn_4O_8$	Ce(IV)	0.035	4
$CaMn_2O_4.4H_2O$	Ce(IV)	0.32	5
$CaMn_2O_4.H_2O$	Ce(IV)	0.54	5
Mn_2O_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 O_2/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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