

## Supplementary Information

### **Manganese sesquioxide to trimanganese tetroxide hierarchical hollow nanostructures: effect of gadolinium on structural, thermal, optical and magnetic properties**

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The growth stages of manganese oxide at different temperatures were examined (Fig S1). HRTEM images reveals that the particles were close to distinct spheres with little aggregation of rod like structure due to the gadolinium ion presence and little agglomeration could be due to the higher temperature, in agreement with the FESEM results. The FESEM-EDAX images (Fig. S2) evidences the presence of gadolinium, manganese, oxygen, and aluminum. The aluminum element was obtained from the surface of the alumina sheets on the copper grid. The average diameter of  $\approx 152$  nm for  $\text{Mn}_2\text{O}_3$  and  $\approx 18$  nm (core diameter),  $\approx 21$  nm (breadth) were measured for Gd-doped  $\text{Mn}_3\text{O}_4$  (Fig S3). The  $\text{Mn}_2\text{O}_3$  was attained between the temperatures 310-490 °C was evidenced by the sufficient weight loss (Fig. S4).

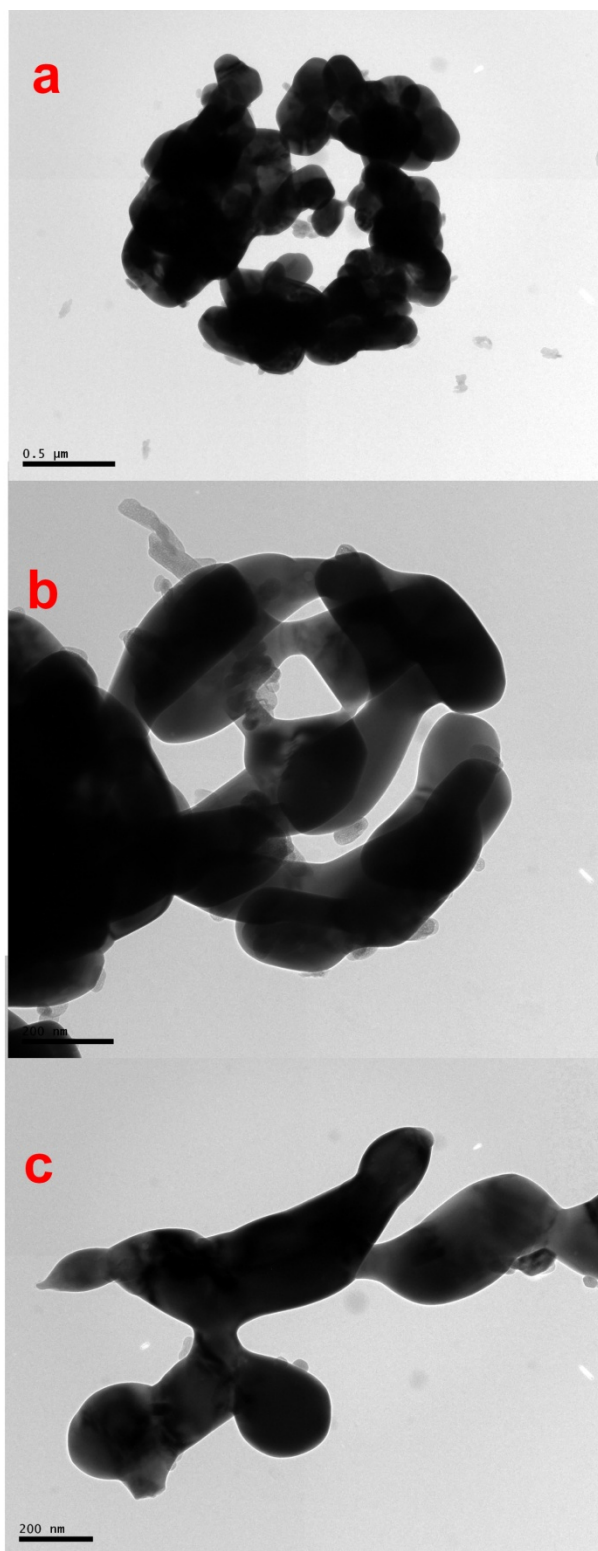


Fig. S1. HRTEM images of  $\text{Mn}_2\text{O}_3$  calcined at (a) 450, (b) 700, and (c) 900 °C.

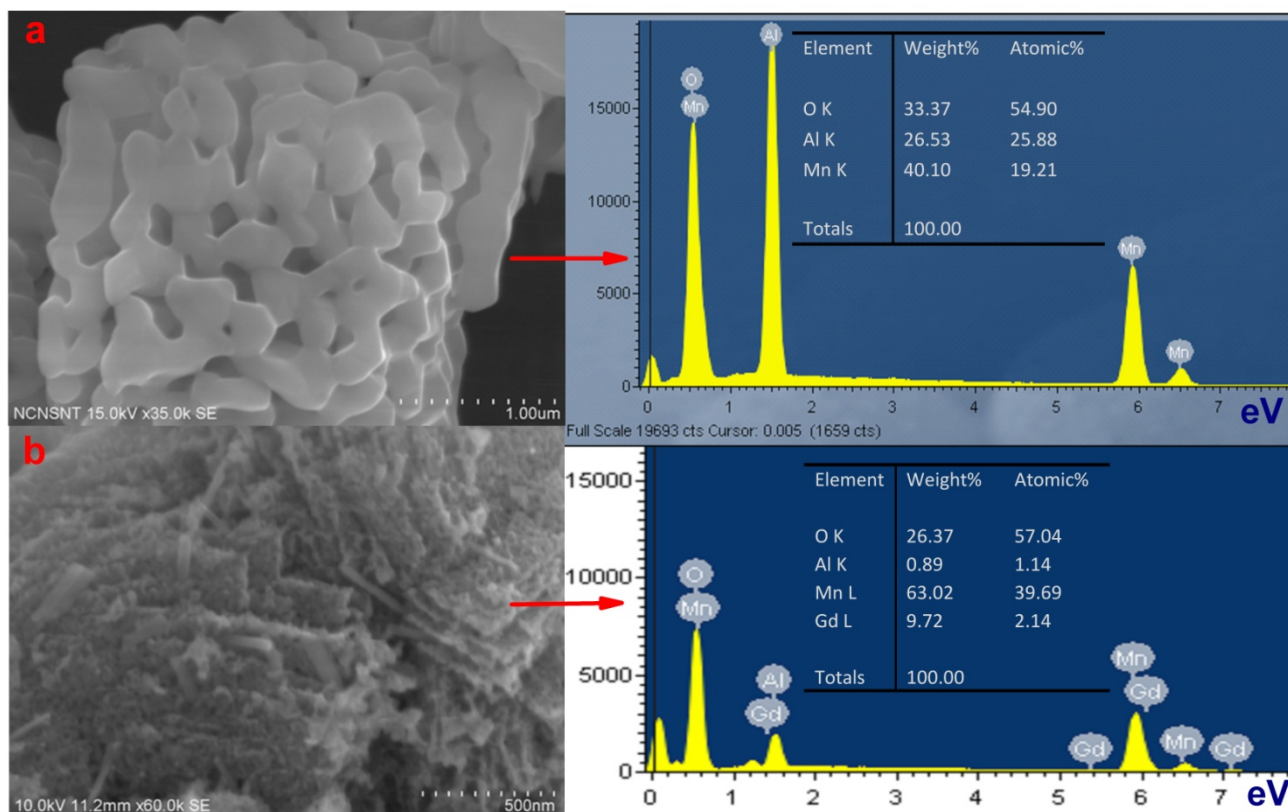


Fig. S2. FESEM-EDAX images of (a) Gd-doped manganese oxide, and (b) manganese oxide, calcined at 700 °C respectively.

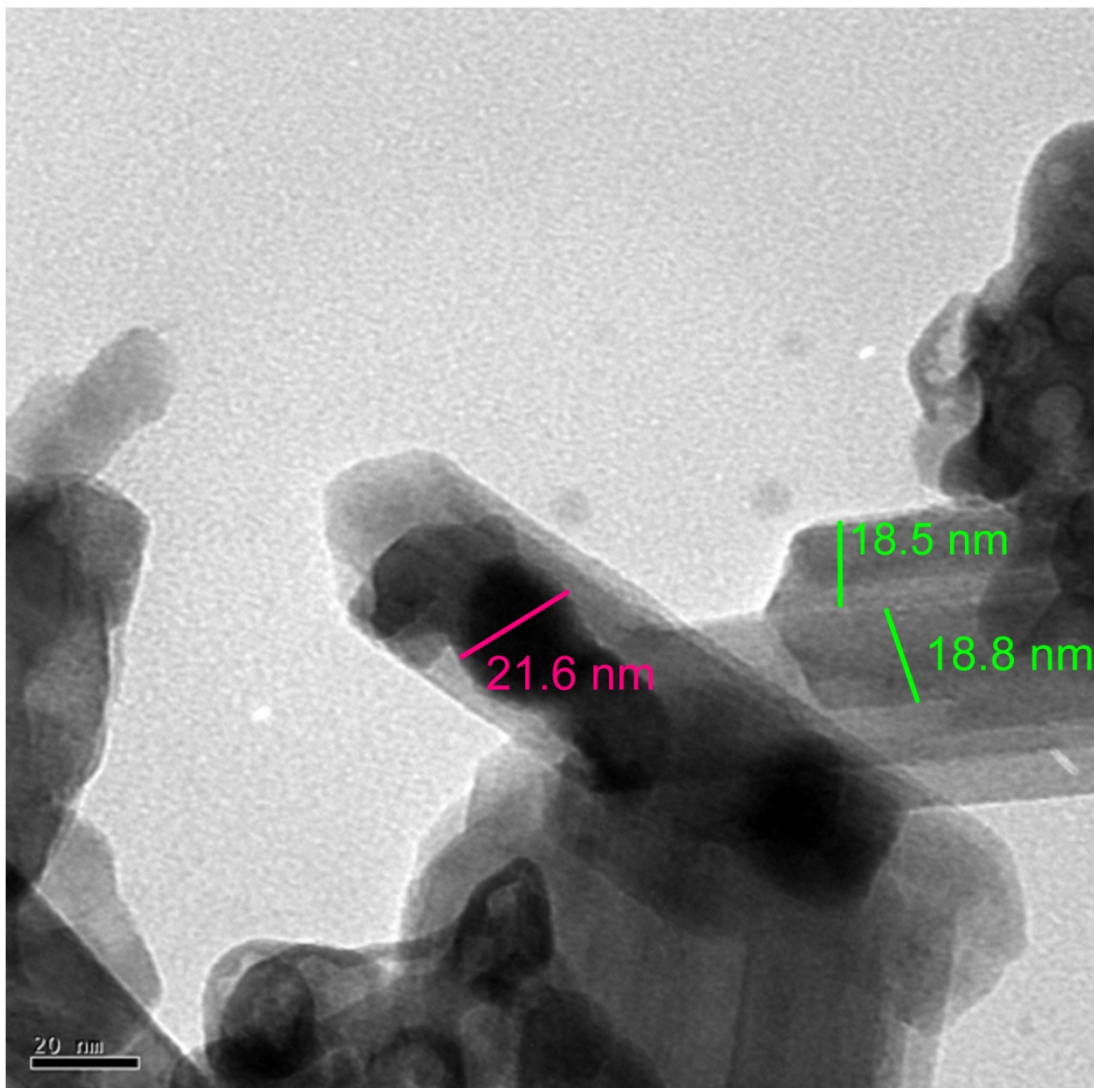


Fig. S3. HRTEM images of Gd-doped Mn<sub>3</sub>O<sub>4</sub> calcined at 700 °C.

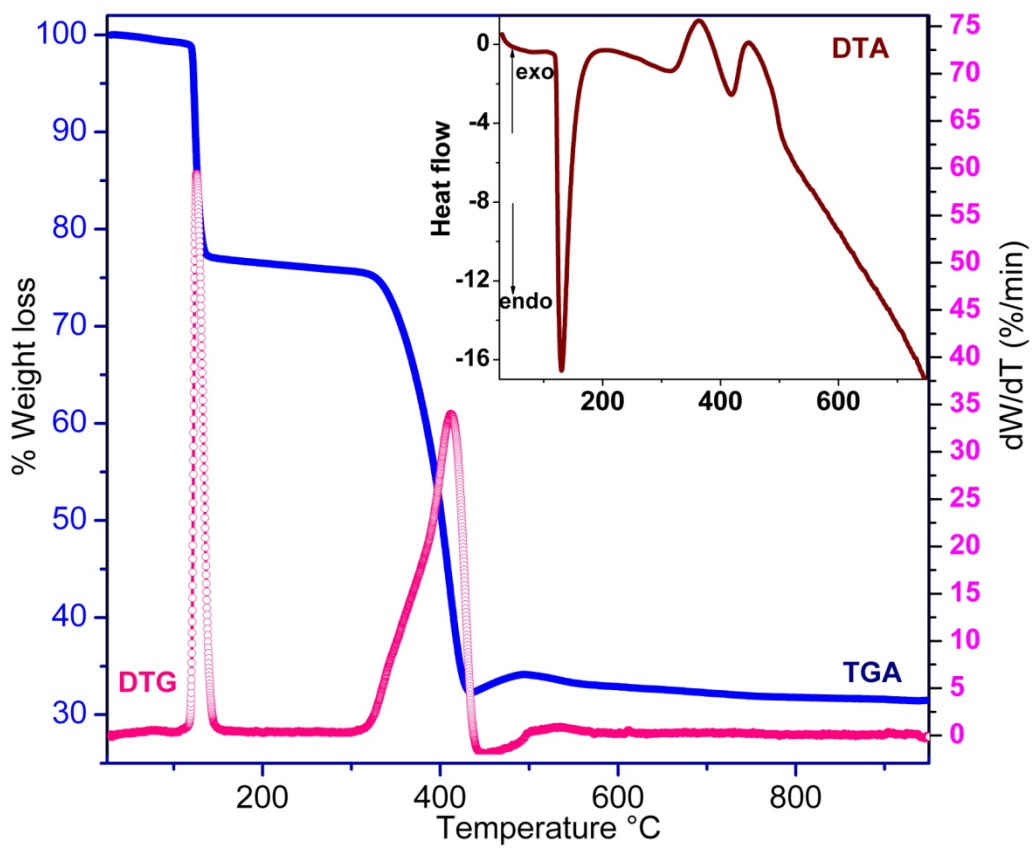


Fig. S4. TG-DTA-DTG of  $\text{MnC}_2\text{O}_4$