

## Supporting Information

### **Large-scale size-controlled synthesis of cryptomelane-type manganese oxide OMS-2 in lateral and longitudinal directions”**

**Qin Zhang, Xiaodi Cheng, Xionghan Feng\*, Guohong Qiu, Wenfeng Tan and Fan Liu\***

Key Laboratory of Subtropical Agriculture Resource and Environment, Ministry of Agriculture, College of Resources & Environment, Huazhong Agricultural University, Wuhan, China. E-mail: [chincheung\\_chn@hotmail.com](mailto:chincheung_chn@hotmail.com) and [fxh73@mail.hzau.edu.cn](mailto:fxh73@mail.hzau.edu.cn);  
Fax: +86 27 87280670; Tel: +86 27 87280271.

#### **1. Details in synthesis**

In a typical synthesis, 50 mL aqueous mixture containing 0.3 mol carboxylic acid was added to 200 ml 0.4 mol/L KMnO<sub>4</sub> in a 1 L triangle beaker connected with a condensation device. Five different alkyl chain lengths of straight chain saturated fatty carboxylic acids (acetic acid (C<sub>2</sub>H<sub>4</sub>O<sub>2</sub>), propionic acid (C<sub>3</sub>H<sub>6</sub>O<sub>2</sub>), butyric acid (C<sub>4</sub>H<sub>8</sub>O<sub>2</sub>), valeric acid (C<sub>5</sub>H<sub>10</sub>O<sub>2</sub>) and heptanoic acid (C<sub>7</sub>H<sub>14</sub>O<sub>2</sub>)) were used in the experiment, respectively. The mixture was heated to 100°C and kept at reflux under vigorous stirring on an oil bath heater. After 12 h of reaction, the product was collected by centrifuge and directly detected by IR after drying at room temperature.

The residual sample was washed with distilled deionized water until the conductivity of supernatant was below  $20.0 \mu\text{S cm}^{-1}$ , and then freeze-dried.

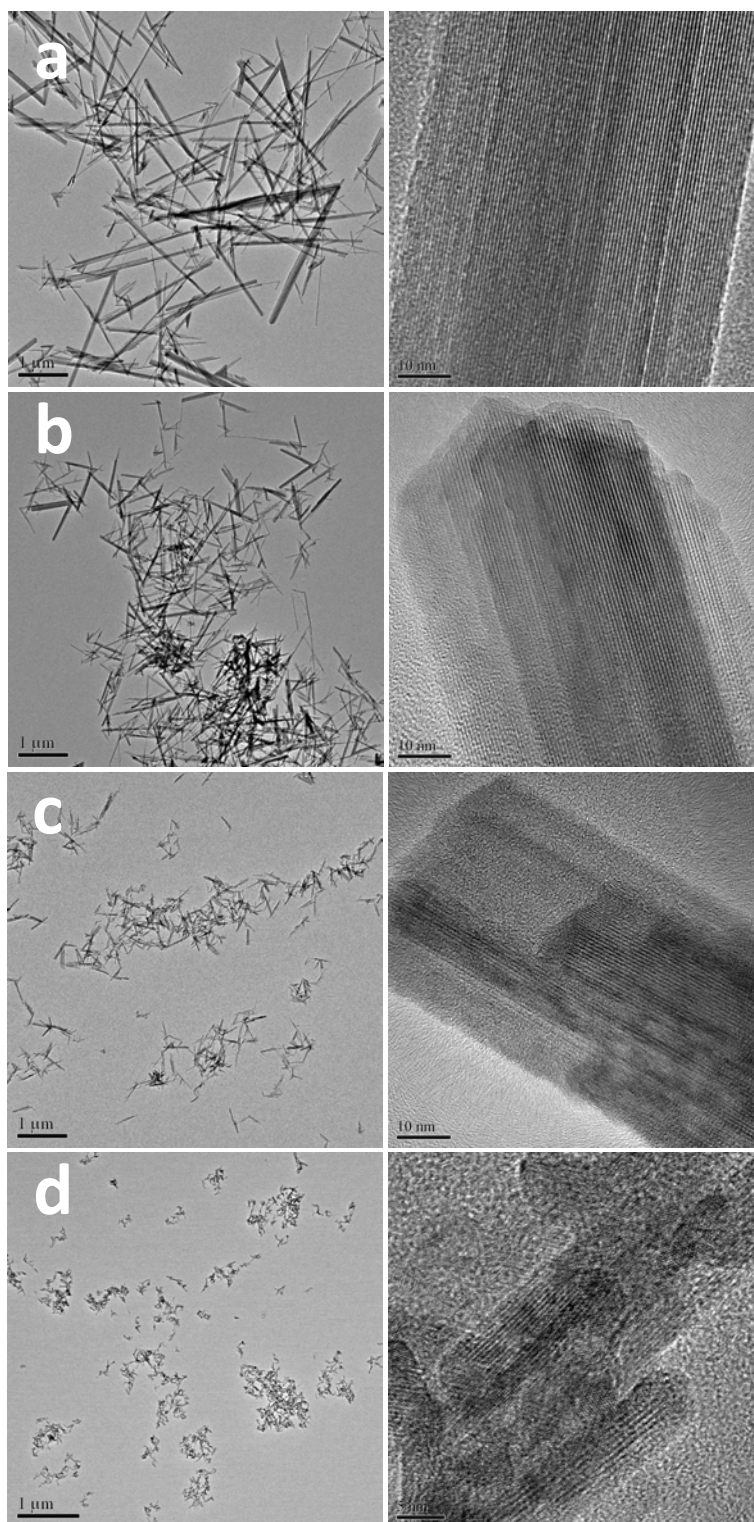
## 2. Analysis Techniques

The X-ray diffraction (XRD) analysis was performed with a Bruker D8 advance X-ray diffractometer equipped with a Cu K $\alpha$  ( $\lambda = 0.15406$ ) radiation source operated at a tube voltage of 40 kV and a tube current of 40 mA. The data were collected in a step scan mode using steps of  $0.02^\circ$  with a scanning rate of  $1^\circ/\text{min}$  in the  $2\theta$  range from  $5^\circ$  to  $85^\circ$ .

For transmission electron microscopy, a JEM-2010F was used operating at an accelerating voltage of 200 kV. The samples for TEM and HRTEM analysis were dispersed in absolute ethyl alcohol, and ultrasonically dispersed. A drop of nano scale OMS-2 powder suspension was placed onto a holey carbon film supported by a 3 mm copper grid and then allowed the solvent to evaporate.

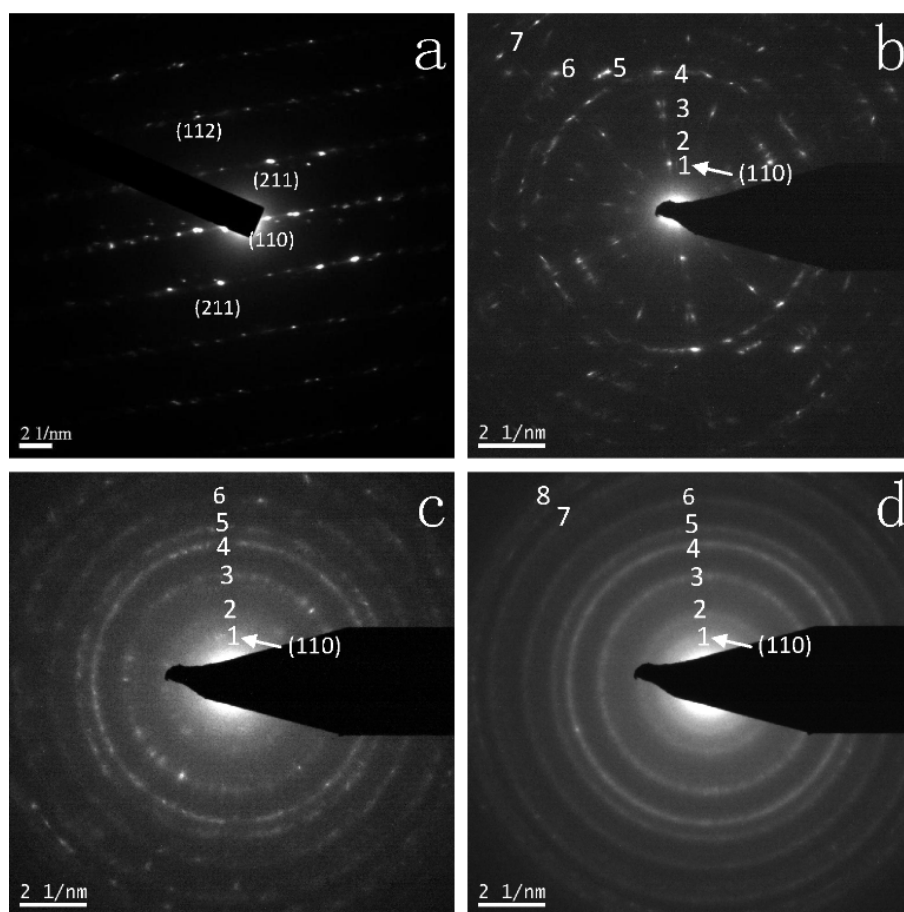
Fourier transform infrared (FTIR) spectra were collected with a Bruker Equinox 55 model spectrophotometer by making pellets with KBr. The resolution was set at  $4 \text{ cm}^{-1}$  with a scan number of 32.

### 3. HRTEM images



**Fig. S1** HRTEM images of OMS-2 nanoparticles prepared with different carboxylic acids: (a)  $C_2H_4O_2$ , (b)  $C_3H_6O_2$ , (c)  $C_4H_8O_2$  and (d)  $C_5H_{10}O_2$ .

#### 4. SAED images and Indexing of the ED patterns



**Fig. S2** SAED patterns of the products prepared with different carboxylic acids: (a)  $\text{C}_2\text{H}_4\text{O}_2$ , (b)  $\text{C}_3\text{H}_6\text{O}_2$ , (c)  $\text{C}_4\text{H}_8\text{O}_2$  and (d)  $\text{C}_5\text{H}_{10}\text{O}_2$ .

**Table S1** Indexing of the SAED patterns in [Fig. S2](#)

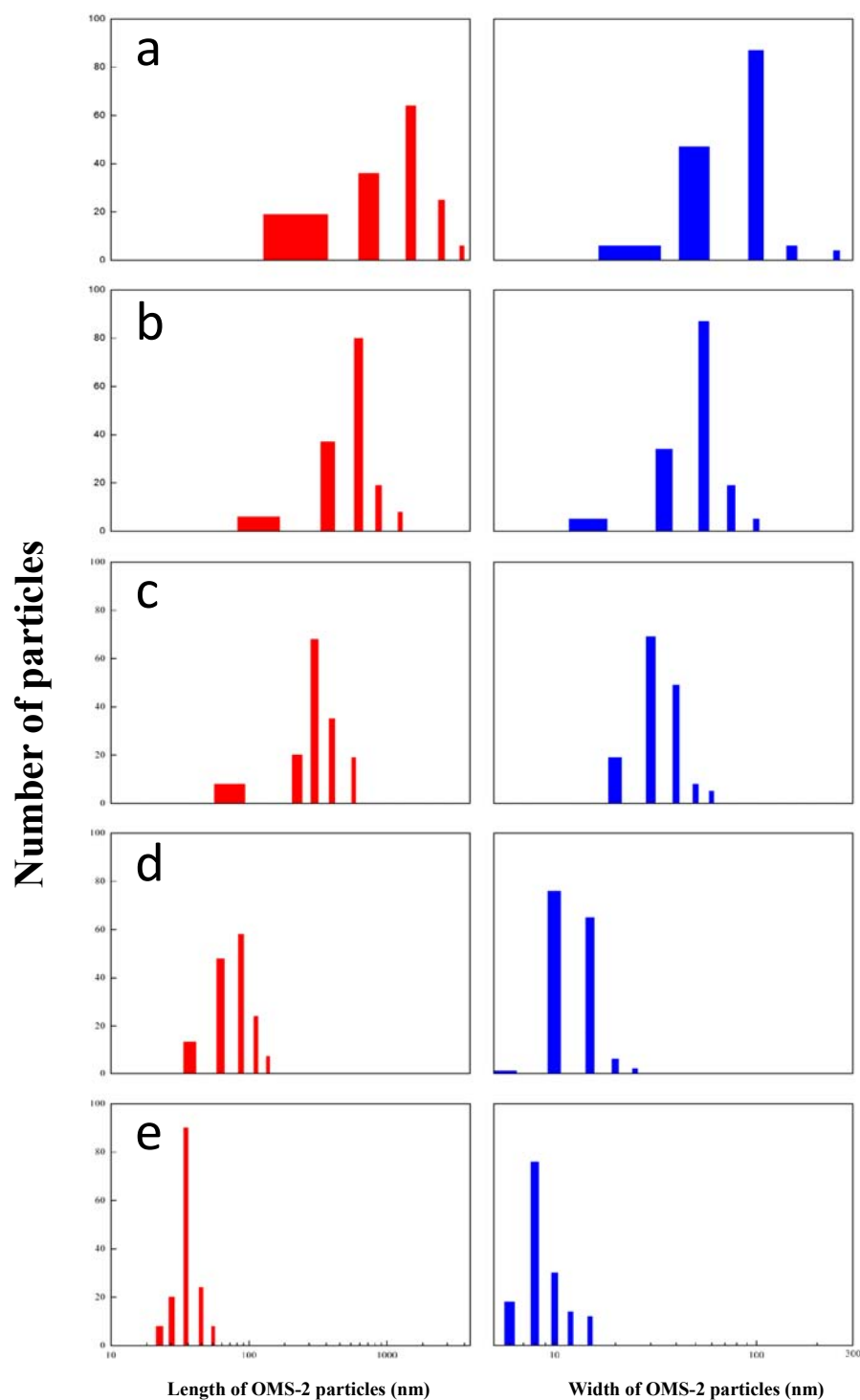
| Sample No. | Ring No. | Determined d (nm) | Phase | Index<br>h k l | Standard d*<br>(nm) |
|------------|----------|-------------------|-------|----------------|---------------------|
| (b)        | 1        | 0.689             | C     | 1 1 0          | 0.692               |
|            | 2        | 0.484             | C     | 2 0 0          | 0.489               |
|            | 3        | 0.307             | C     | 3 1 0          | 0.309               |
|            | 4        | 0.239             | C     | 2 1 1          | 0.240               |
|            | 5        | 0.214             | C     | 3 0 1          | 0.215               |
|            | 6        | 0.182             | C     | 4 1 1          | 0.183               |
|            | 7        | 0.140             | C     | 1 1 2          | 0.140               |

| Sample No. | Ring No. | Determined d (nm) | Phase | Index<br>h k l | Standard d*<br>(nm) |
|------------|----------|-------------------|-------|----------------|---------------------|
| (c)        | 1        | 0.689             | C     | 1 1 0          | 0.692               |
|            | 2        | 0.484             | C     | 2 0 0          | 0.489               |
|            | 3        | 0.307             | C     | 3 1 0          | 0.309               |
|            | 4        | 0.239             | C     | 2 1 1          | 0.240               |
|            | 5        | 0.214             | C     | 3 0 1          | 0.215               |
|            | 6        | 0.182             | C     | 4 1 1          | 0.183               |

| Sample No. | Ring No. | Determined d (nm) | Phase | Index<br>h k l | Standard d*<br>(nm) |
|------------|----------|-------------------|-------|----------------|---------------------|
| (d)        | 1        | 0.689             | C     | 1 1 0          | 0.692               |
|            | 2        | 0.484             | C     | 2 0 0          | 0.489               |
|            | 3        | 0.307             | C     | 3 1 0          | 0.309               |
|            | 4        | 0.239             | C     | 2 1 1          | 0.240               |
|            | 5        | 0.214             | C     | 3 0 1          | 0.215               |
|            | 6        | 0.182             | C     | 4 1 1          | 0.183               |
|            | 7        | 0.162             | C     | 6 0 0          | 0.163               |
|            | 8        | 0.140             | C     | 1 1 2          | 0.140               |

\*OMS-2 (JCPDS file no. 44-0141)

### 5. Length distribution and width distribution of the OMS-2



**Fig. S3** Length distribution (Red color) and width distribution (Blue color) of the OMS-2 prepared with different carboxylic acids (sample size 150 nanoparticles): (a) C<sub>2</sub>H<sub>4</sub>O<sub>2</sub>, (b) C<sub>3</sub>H<sub>6</sub>O<sub>2</sub>, (c) C<sub>4</sub>H<sub>8</sub>O<sub>2</sub>, (d) C<sub>5</sub>H<sub>10</sub>O<sub>2</sub> and (e) C<sub>7</sub>H<sub>14</sub>O<sub>2</sub>.

6. Range, mean and standard deviation of the OMS-2 nanoparticle sizes

**Table S2 Range, mean and standard deviation of the OMS-2 nanoparticle sizes**

| sample  | Range (nm) |       | Mean (nm) |       | Standard Deviation |       |
|---|------------|-------|-----------|-------|--------------------|-------|
|   | Length     | Width | Length    | Width | Length             | Width |
| C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>  | 3670.4     | 209.7 | 1376.1    | 61.1  | 806.9              | 29.3  |
| C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>  | 1176.0     | 101.1 | 631.9     | 45.3  | 242.4              | 18.3  |
| C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>  | 591.8      | 59.9  | 336.5     | 30.8  | 114.7              | 10.1  |
| C <sub>5</sub> H <sub>10</sub> O <sub>2</sub> | 116.1      | 17.2  | 79.2      | 10.4  | 24.7               | 3.3   |
| C <sub>7</sub> H <sub>14</sub> O <sub>2</sub> | 35.1       | 11.0  | 35.6      | 8.2   | 7.9                | 2.3   |