

## Supplementary information

### $\alpha$ -Cellulose fibers of paper-waste origin surface-modified with Fe<sub>3</sub>O<sub>4</sub> and thiolated-chitosan for efficacious immobilization of laccase

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## Methods S1: Characterizations

The morphology of the  $\alpha$ -Cellulose-Fe<sub>3</sub>O<sub>4</sub>-CTNs-SH was observed by high-resolution transmission electron microscopy (HR-TEM) analysis (Tecnai G2 transmission electron microscope, Hillsboro, OR, USA). The sample for HR-TEM analysis was repapered by ultrasonically dispersing the  $\alpha$ -Cellulose-Fe<sub>3</sub>O<sub>4</sub>-CTNs-SH solution for 1 hour (Sonics Vibra-Cell VC130 Ultrasonic Processor, Sonics & Materials, Inc., Newtown, CT, USA). The sample was drop coated on the carbon HR-TEM grid. The crystalline nature of the  $\alpha$ -Cellulose-Fe<sub>3</sub>O<sub>4</sub>-CTNs-SH was evaluated by the X-ray powder diffractometer (XRD, Cu-K $\alpha$  radiation ( $\lambda = 1.5418 \text{ \AA}$ ), Ultima IV/Rigaku, Tokyo, Japan) analysis. The  $\alpha$ -Cellulose-Fe<sub>3</sub>O<sub>4</sub>-CTNs-SH magnetic properties were carried out by vibrating sample magnetometer (VSM, Lakeshore, Model: 7407, LA, USA). The surface elemental profile of  $\alpha$ -Cellulose-Fe<sub>3</sub>O<sub>4</sub>-CTNs-SH-Laccase (in powder form) were analyzed by X-ray photoelectron spectroscopy (XPS, Theta Probe AR-XPS System, Thermo Fisher Scientific, Dartford, UK). The functional group profile of samples;  $\alpha$ -Cellulose-Fe<sub>3</sub>O<sub>4</sub>-CTNs-SH and  $\alpha$ -Cellulose-Fe<sub>3</sub>O<sub>4</sub>-CTNs-SH-Laccase were analyzed by Fourier transform infrared spectroscopy (FT-IR, Spectrum 100, PerkinElmer, Waltham, MA, USA).