Supporting Information

for

Carbonaceous halloysite nanotubes for the stabilization of Co, Ni, Cu and Zn in river sediments

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Including 2 Tables and 2 Figures in 5 pages

Table S1 The fractions of heavy metals and extracting reagents

Fractions	Extracting reagents
The water-soluble fraction (F0)	F0 of sediment is the first to be brought. 0.5 g sediment and 0.05 g curing agent were mixed and then added 25 mL deionized water. It was kept in a cool and dark environment for incubation of one week.
The exchangeable metal and carbonate-associated fractions (F1)	0.5 g sediment and 0.05 g curing agent were mixed with 25 mL 0.11 M acetic acid (pH 2.0), then shaken at 30 rpm for 16 h at 25 °C, after that centrifuged at 4000 rpm for 20 min. The supernatant was measured for metal concentration, and the residue was used for extraction in next step.
The fraction associated with Fe-Mn oxides (F2)	25 mL 0.5 M hydroxylammonium chloride were added to the previous residue (pH 2.0). The mixture was shaken at 30 rpm for 16 h at 25 °C, then centrifuged at 4000 rpm for 20 min. The supernatant was measured for metal concentration, and the residue was used for the next extraction.
The fraction bound to organic matter (F3)	The residue was incubated with 5 mL 30% hydrogen peroxide 1 h at 25 °C. Another 5 mL 30% hydrogen peroxide were added and the mixture was heated 1 h at 85 °C. After adding 25 mL 1 M ammonium acetate (pH 2.0), the mixture was shaken at 30 rpm for 16 h at 25 °C, then centrifuged at 4000 rpm for 20 min. The supernatant was measured for metal concentration, and the residue was used for the digestion in the next step.
The residual fraction (F4)	The F4 of the sediment was determined by the microwave digestion using the acid mixture ($HCl+HNO_3+HF$ = 3+9+4 mL). The samples were then transferred to Teflon bombs and digested in a high performance microwave digestion system-microwave oven (ETHOS UP, Milestone, Italy). The concentrations of four heavy metals (Co, Ni, Cu and Zn) were analyzed by an inductively coupled plasma-mass spectrometry (ICP-MS, 7700, Agilent Technologies, USA) under optimum measurement conditions.

Table S2 Leaching characteristics of the sediment amended by HNTs@CRC and HNTs@CRC/$Ca(OH)_2$ at different times

Heavy metals			Co	Ni	Cu	Zn
Content		mg/kg	328.30	286.70	1115.80	1186.90
MLV		mg/L	16.42	14.34	55.79	59.35
18 h	HNTs@CRC	TCLP mg/L	0.22	2.76	9.22	21.42
		SR %	98.65	80.71	83.48	63.90
		pH	3.71			
	HNTs@CRC/$Ca(OH)_2$	TCLP mg/L	0.19	2.35	5.18	15.44
		SR %	98.82	83.58	90.71	73.99
		pH	4.23			
72 h	HNTs@CRC	TCLP mg/L	0.28	3.12	9.87	22.57
		SR %	98.29	78.24	82.31	61.97
		pH	3.68			
	HNTs@CRC/$Ca(OH)_2$	TCLP mg/L	0.20	2.42	5.46	16.80
		SR %	98.78	83.12	90.21	71.69
		pH	4.21			
264 h	HNTs@CRC	TCLP	0.27	3.11	8.93	23.64
		SR %	98.36	78.30	83.99	60.17
		pH	3.80			
	HNTs@CRC/$Ca(OH)_2$	TCLP	0.22	2.36	5.15	17.64
		SR %	98.66	83.54	90.77	70.28
		pH	4.33			

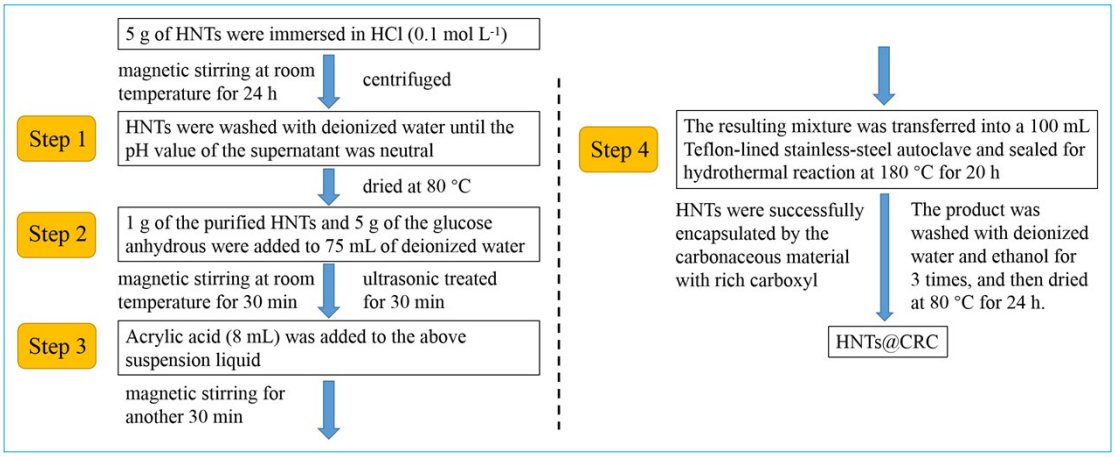
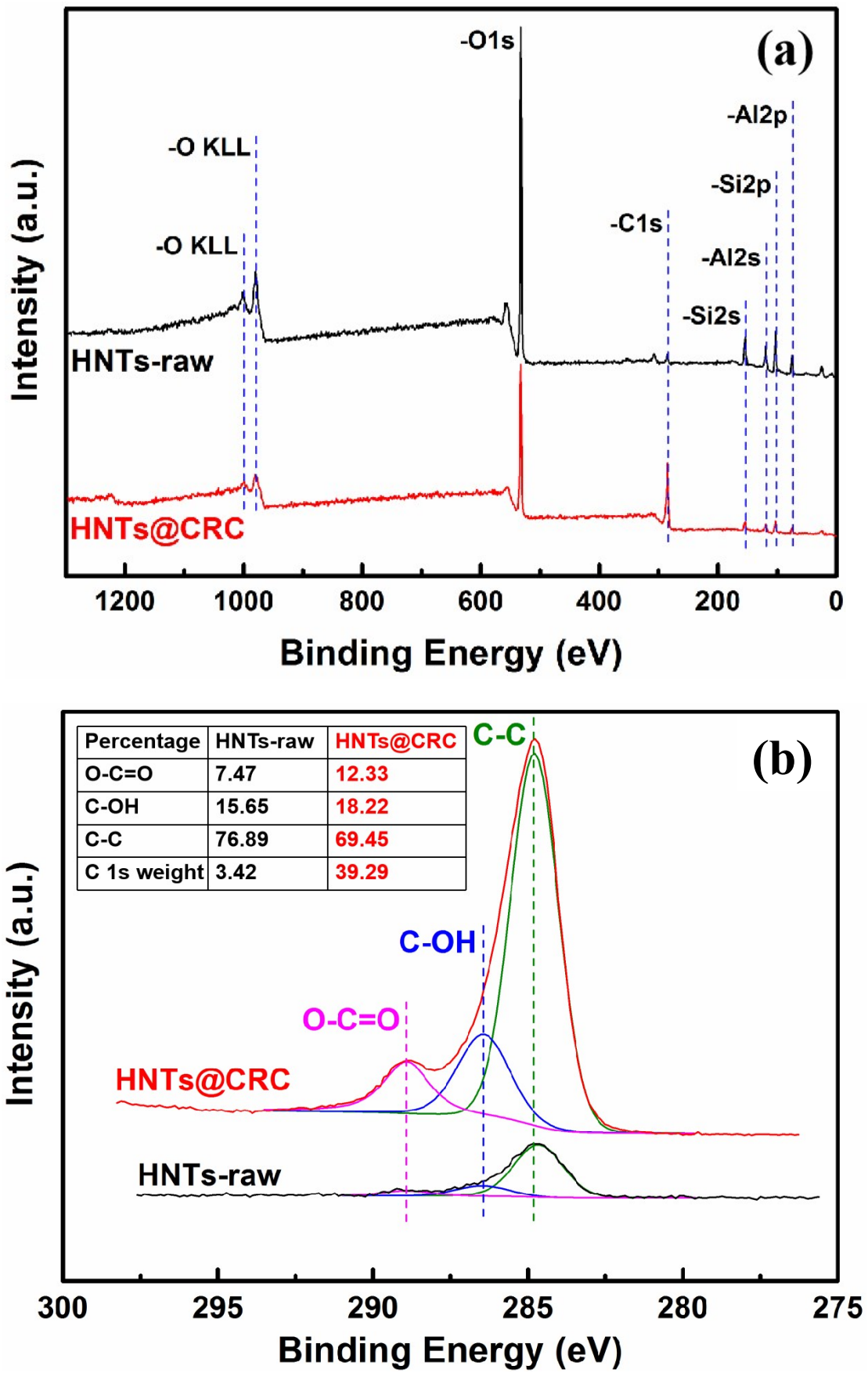


Fig. S1 Four steps for the fabrication of the HNTs@CRC (halloysite nanotubes@carbon with rich carboxylic groups).



Percentage	HNTs-raw	HNTs@CRC
O-C=O	7.47	12.33
C-OH	15.65	18.22
C-C	76.89	69.45
C 1s weight	3.42	39.29

Fig. S2 XPS spectra of full range (a) and C 1s (b) of HNTs-raw (natural halloysite nanotubes) and HNTs@CRC (halloysite nanotubes@carbon with rich carboxylic groups).