Electronic Supplementary Information (ESI)

A multifunctional magnetic hybrid synthesized for adsorption of environmental contaminants

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Experimental

Synthesis of the FOASH material

10 g of commercial ferric oxide particles (content >99.5%, spherical particle size <20 nm, Aladdin Reagents Co., China) was dispersed into 200 ml of deionized water and mixed for 10 min with an ultrasonic fragmentation device (Model JY92-II, Xinzhi Biotechnol. Co, Ltd, Ningbo, China). 150 ml of 30% octadecyl dimethyl hydroxyethyl quaternary ammonium nitrate (content 60% in aqueous solution, Zhejiang Runtu Co., Ltd, China) was added under vigorous stirring for 10 min. By mixed thoroughly with 150 ml of 10% magnesium nitrate, 300 ml of 10% sodium silicate was added rapidly under stirring. After stationarily aging for 24 h, the hybrid material was washed repeatedly with deionized water to remove excess OA and then diluted to 1000 ml. The FOASH suspension was used to adsorb pesticides and the dry FOASH ground into powder for characterization of the structure and morphology.

Characterization of the materials' structure and morphology

The IR spectra were measured with a Fourier transform infrared spectrometer (Model NICOLET 5700, ThermoElectron Co., USA) to indicate OA embedded into the FOASH material. The heat weight change of the FOASH and CMOC materials was performed with a thermal gravimetric analyzer (Model TGA/SDTA Q600, Mettler Toledo Co.). A transmission electron microscopy (TEM) (Model TECNAI G2, S-TWIN, FEI Co., USA) was used to characterize the morphology of the FOASH and CMOC materials. The size distribution and surface area of nano pores in the FOASH and CMOC materials were measured with a surface area and porosimetry analyzer (Model ASAP2020, Micromeritics Co., USA).Magnetic properties were measured at room temperature by vibrating sample magnetometry (Model Lakeshore 7407, USA). The SAXRD (Model D/Max-2550 PC, Japan) was recorded using CuK radiation at a voltage of 30 kV and current of 50 mA. Magnetic properties were measured at room temperature by vibrating sample magnetometry (Model Lakeshore 7407, USA).

Adsorption of pesticides to the FOASH material

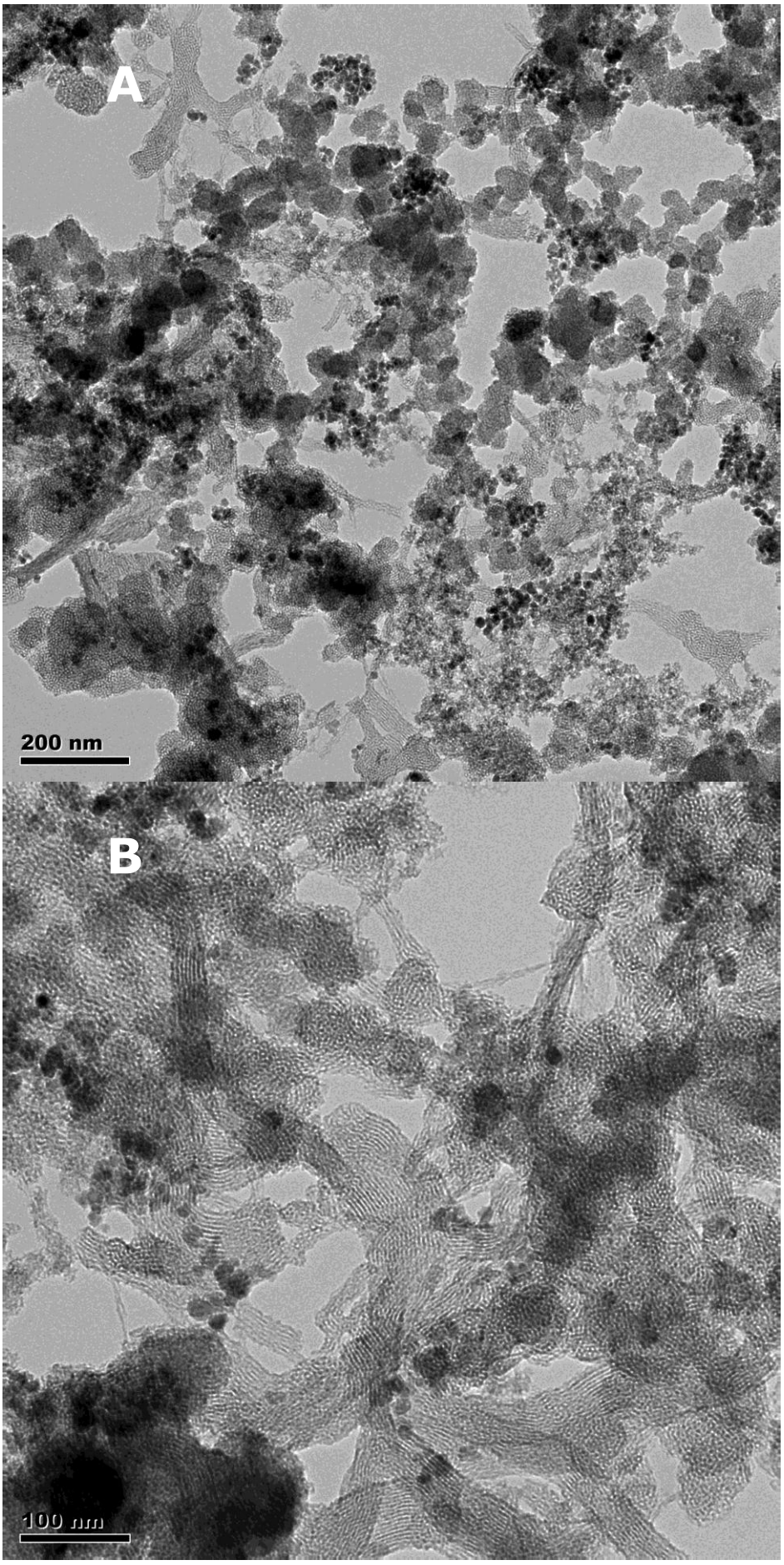
The phoxim and parathion-methyl mixed aqueous solutions were treated with the FOASH material (0.02 and 0.1%(w%)). The liquids were mixed thoroughly for 20 min. After the magnetic separation, their concentrations in the supernatants were determined by high-performance liquid chromatography (HPLC)

with a UV detector (Model LC 2000, Hitachi, Japan). Parathion-methyl and phoxim were detected at 3.7 and 5.1 min at 290 nm. The flow phase consisted of CH_3OH and H_2O according to 80:20 (v/v) at 1 ml/min of the flow speed through a chromatographic column (Model Allsphere ODS-2 5 μm, Length 250 mm). The injection volume was 20 μl of water sample.

Capture of heavy metals ions with the CMOC material

The FOASH sludge adsorbing pesticides was calcined for 2 h at 600 ^{o}C to form the CMOC material and then ground into powder of approximately 200 mesh. It was used to adsorb heavy metals ions from aqueous solution. A heavy metal standard store solution (each metal in 500 mg/L) was prepared with the heavy metal nitrates (Cu, Zn, Pb, Cd and Cr). 0.5%(w%) of the CMOC powder was added into two solutions (one contained ~10 mg/L for every metal and the other ~50 mg/L). The liquids were mixed thoroughly for 10 min. After the magnetic separation, heavy metals and Mg^{2+} in the supernatants were determined with an inductively coupled plasma optical emission spectrometer (ICP-OES) (Model Optima 2100DV, PerkinElmer, USA).

Figures S1 – S4



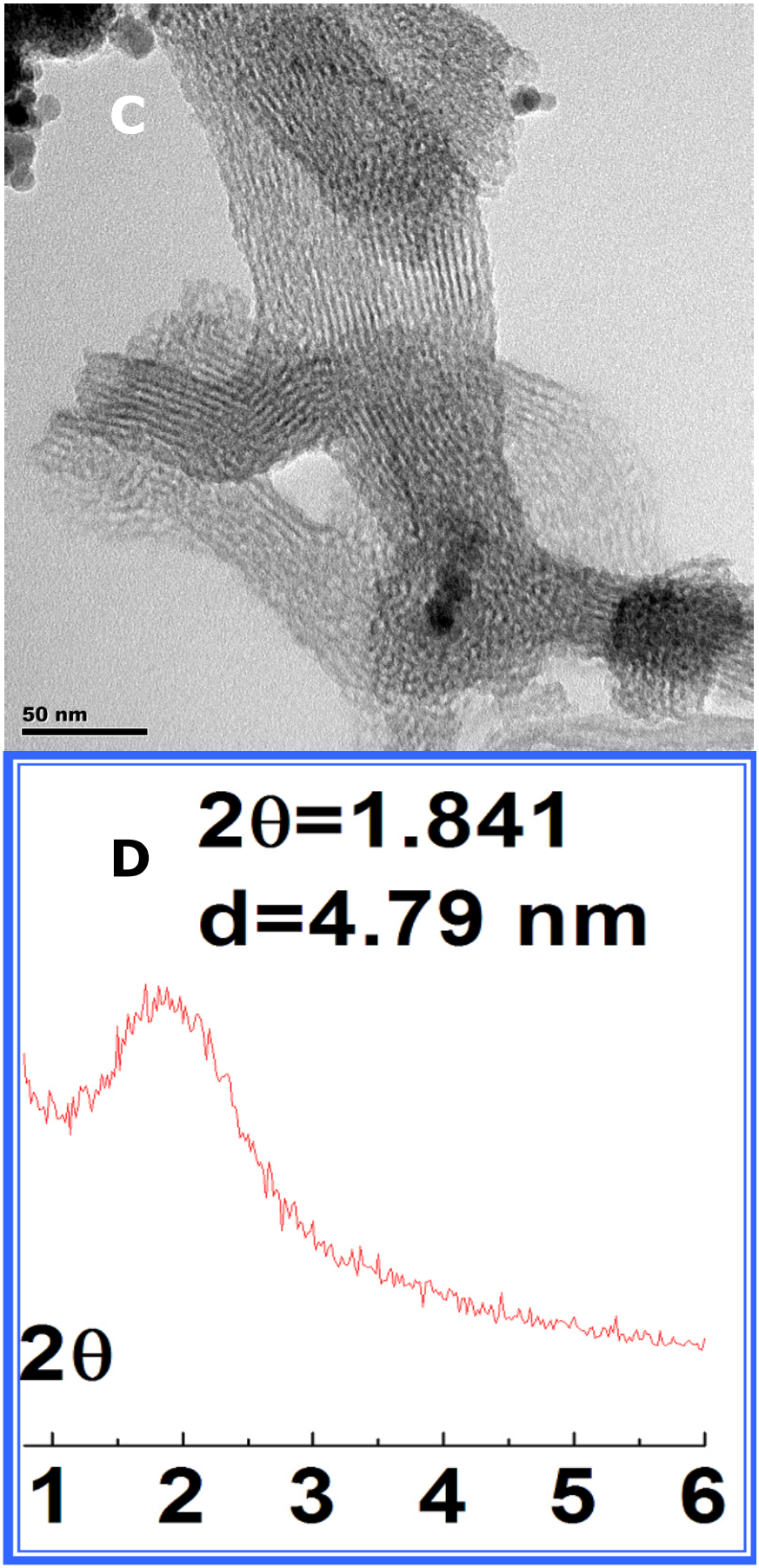
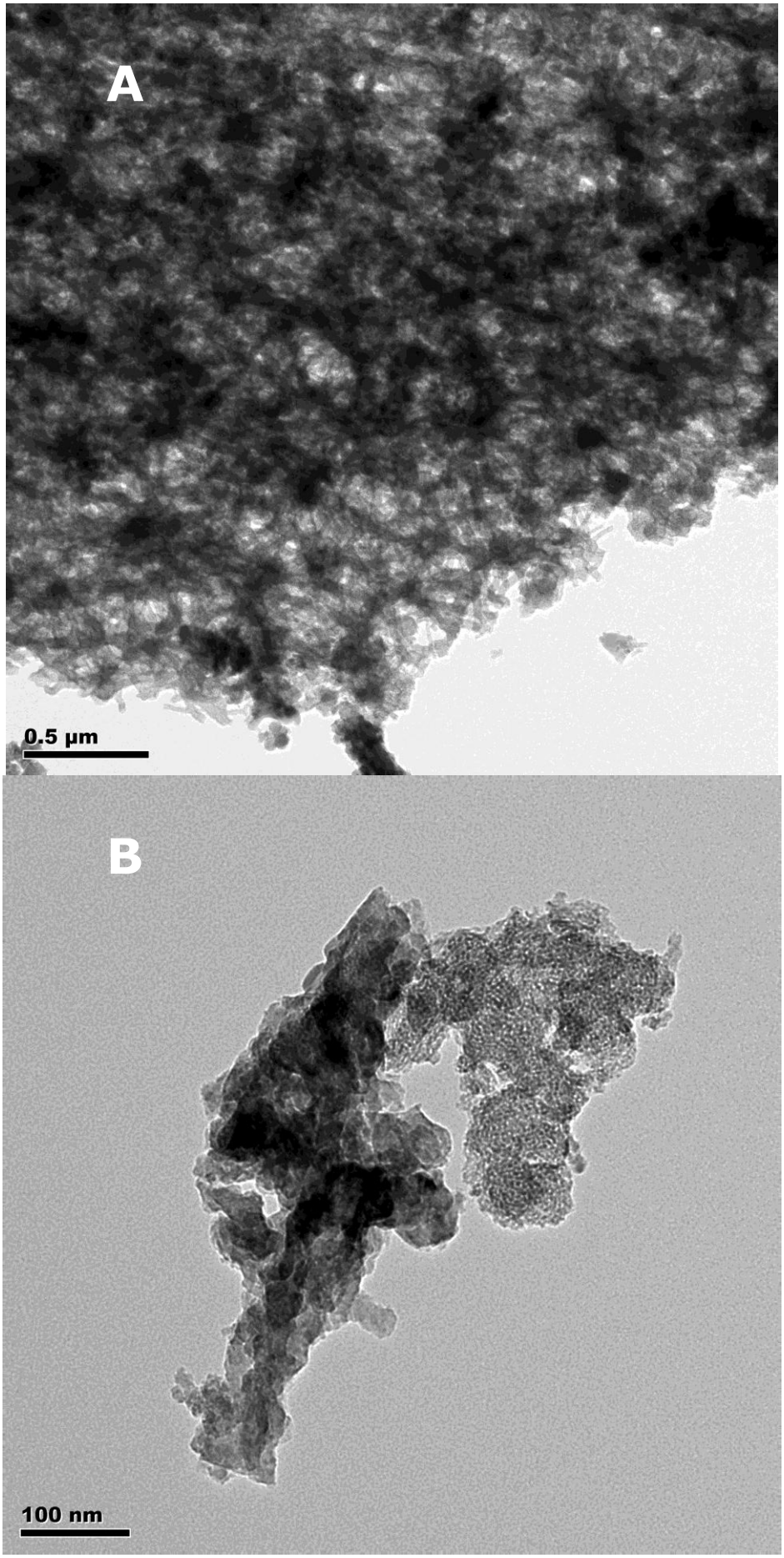


Fig. S1 A to **C**: TEM images of the FOASH material formed with ferromagnetic oxide particles (FOP), magnesium silicate and OA, **D**: SAXRD of the FOASH material



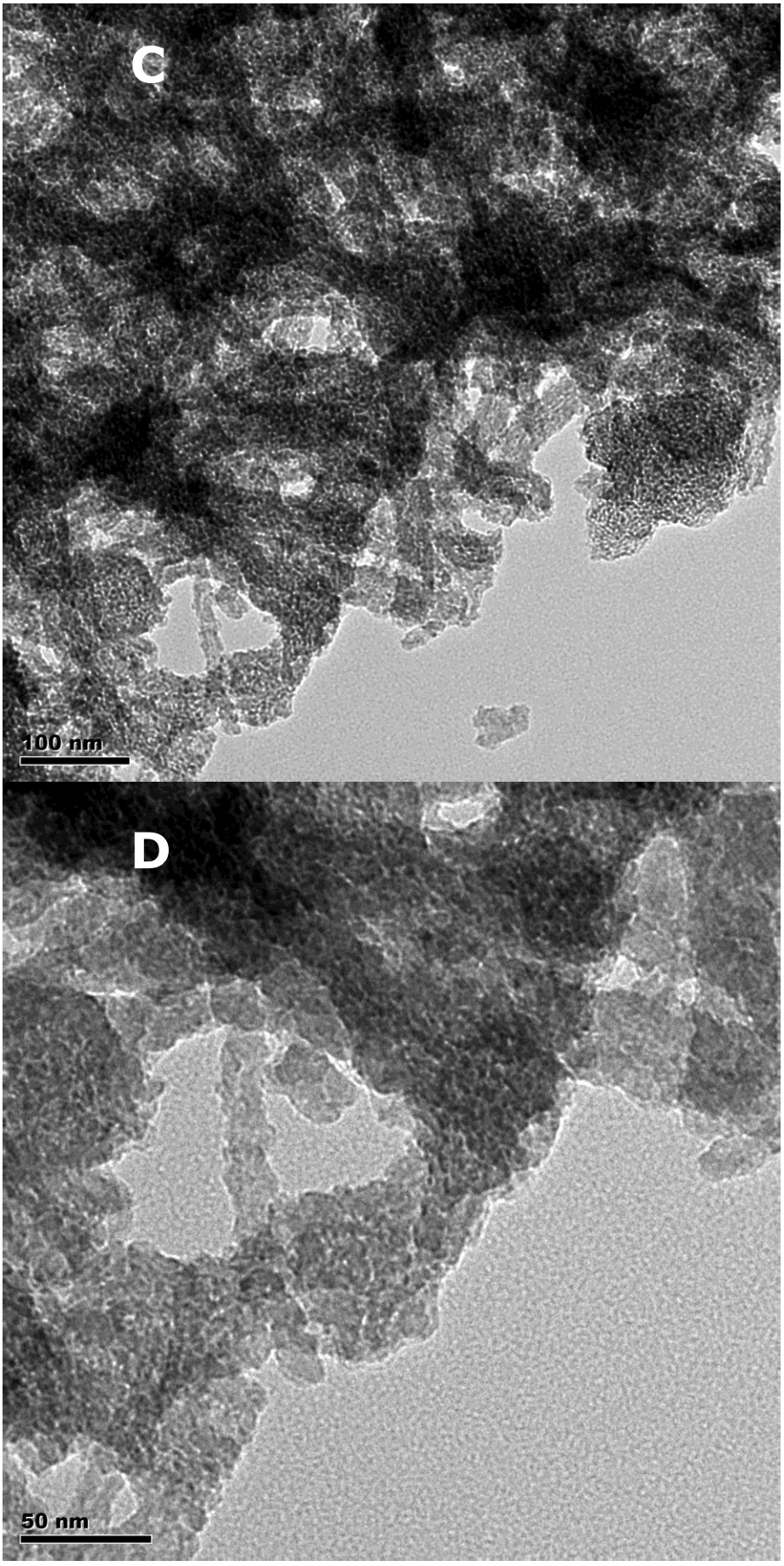


Fig. S2 TEM images of the CMOC material (**A** to **D**)

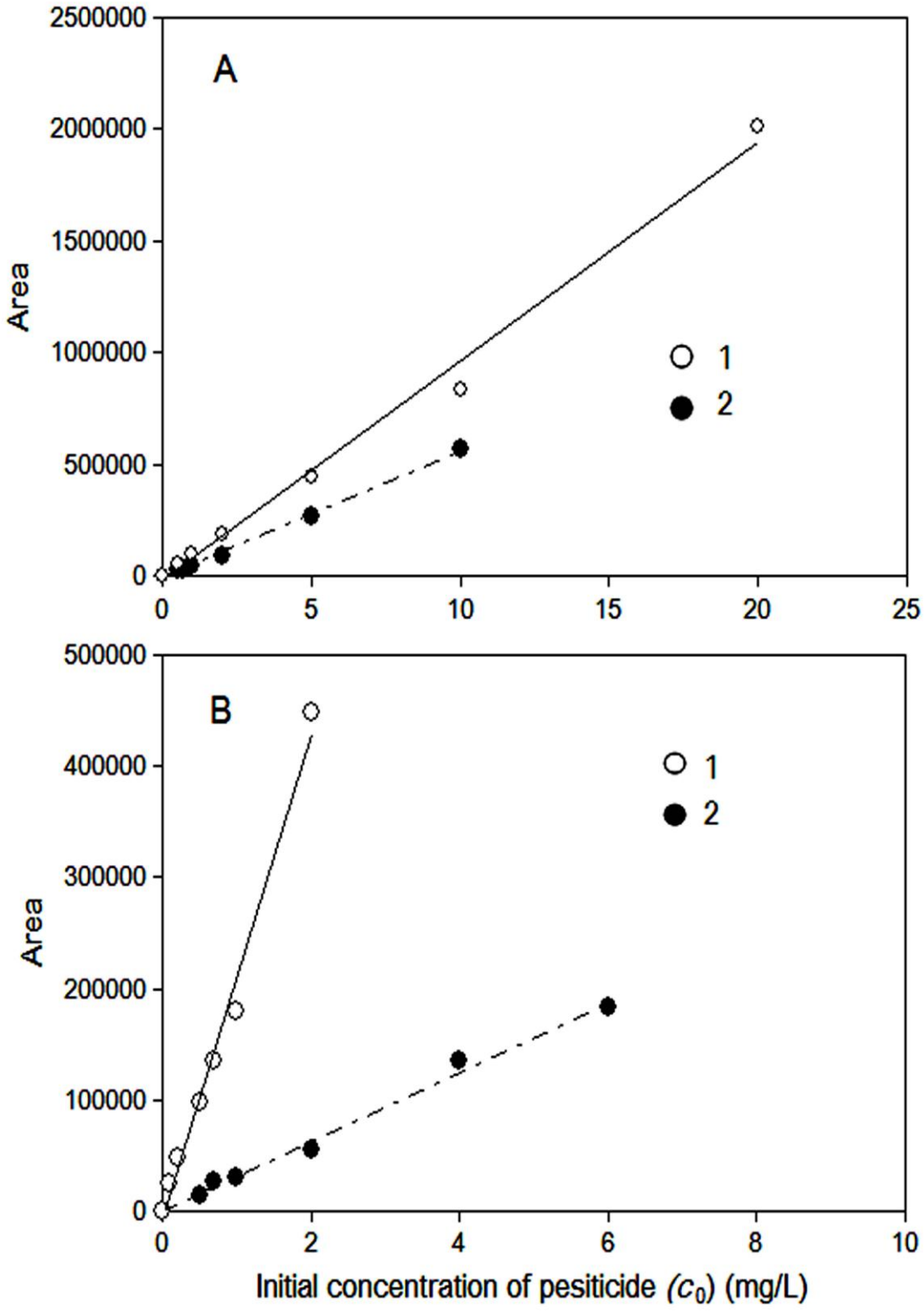


Fig. S3 Chromatographic determinations of parathion-methyl (A) and phoxim(B). 1- Standard curves and 2- pesticides in the supernatants of liquids containing 0.02% of the FOASH material and parathion-methyl between 0.70 and 10.0 mg/L (A) or phoxim between 0.5 and 6.0 mg/L (B).

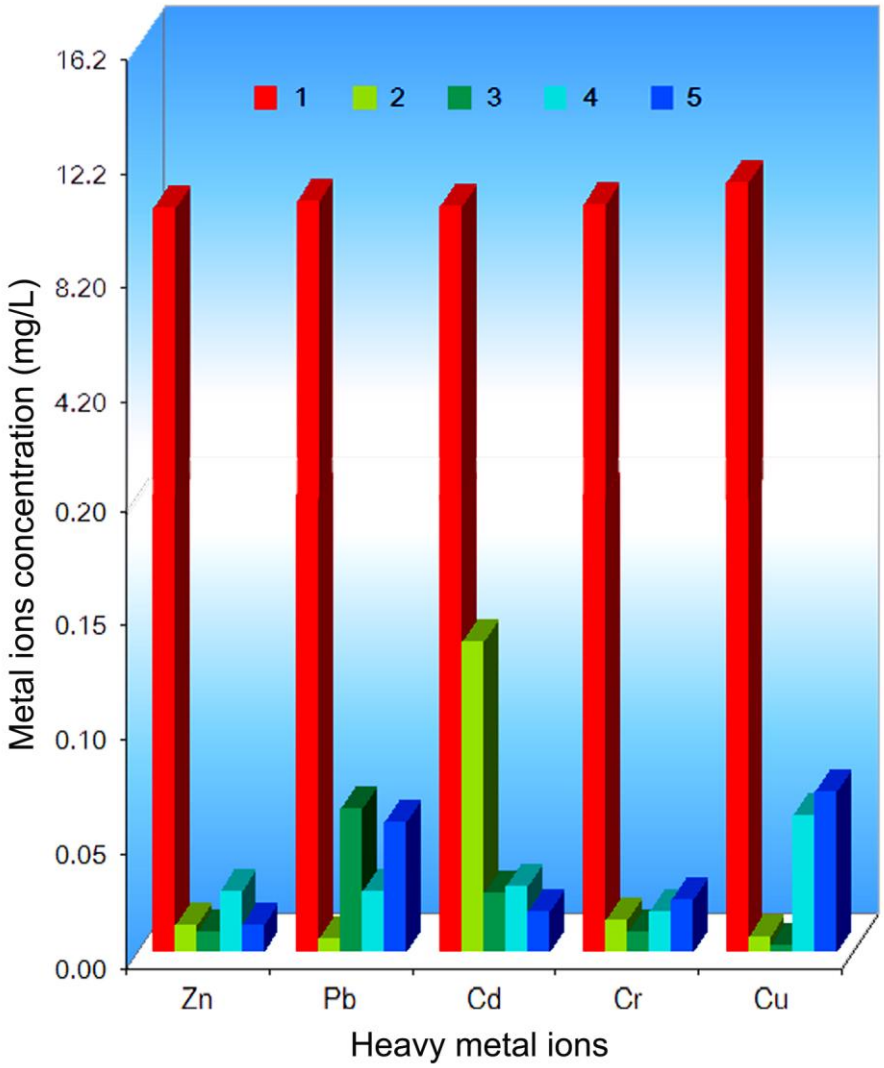


Fig. S4 Effect of pH of heavy metals raw solutions on adsorption of heavy metals. 1- the raw solution, 2- to 5- pH 2.92, 3.96, 4.92 and 5.96 metal solutions treated with 0.3% of the FOASH material.