Supplementary materials for:

Boosting microwave absorption performance of bio-gel derived Co/C nanocomposites

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1. Experimental

1.1 Chemicals and preparation of cobalt/carbon nanocomposites

Cobalt chloride ($CoCl_2 \cdot 6H_2O$) and ammonium bicarbonate (NH_4HCO_3) were bought from Sinopharm Group. Agar powder was purchased from Sinopharm Group and Kevo Chemical. These chemical medicines were produced in chemical pure grade, and the product was used directly without any further treatment. The synthesis process flow chart of Co/C nanocomposites was schematic in **Fig. S1**. The precursor solution was produced by dissolves 12.0 g agar in 160 mL deionized water of 0.15 mol/L $CoCl_2 \cdot 6H_2O$, and is heated at 110 ~ 120 ℃ until the agar powder is completely dissolved. The precursor solution was cured and cooled at 20 ℃ for 2 h, and later 1.2 mol/L NH_4HCO_3 (160 mL) solution was injected into cured precursor gel and sealed at room temperature for 48 h. NH_4HCO_3 permeates the gel and $CoCO_3$ nanoparticles were evenly wrapped in the agar gel for separation. Then the prepared gel precursor is evenly chopped into several parts and is freeze-dried to keep its shape unchanged, after which they are mixed with KOH solids and ground to a fine powder state. The Co/C nanoparticles were obtained by heating at 800 ℃ for six hours in a Nitrogen atmosphere. Continue to change the volume fraction of $CoCl_2 \cdot 6H_2O$ were 0.05 mol/L, 0.15 mol/L, 0.25 mol/L, and set up the blank control group without $CoCl_2 \cdot 6\ H_2O$, repeat the above steps, the preparation of the different volume fraction of Co/C nanometer materials.

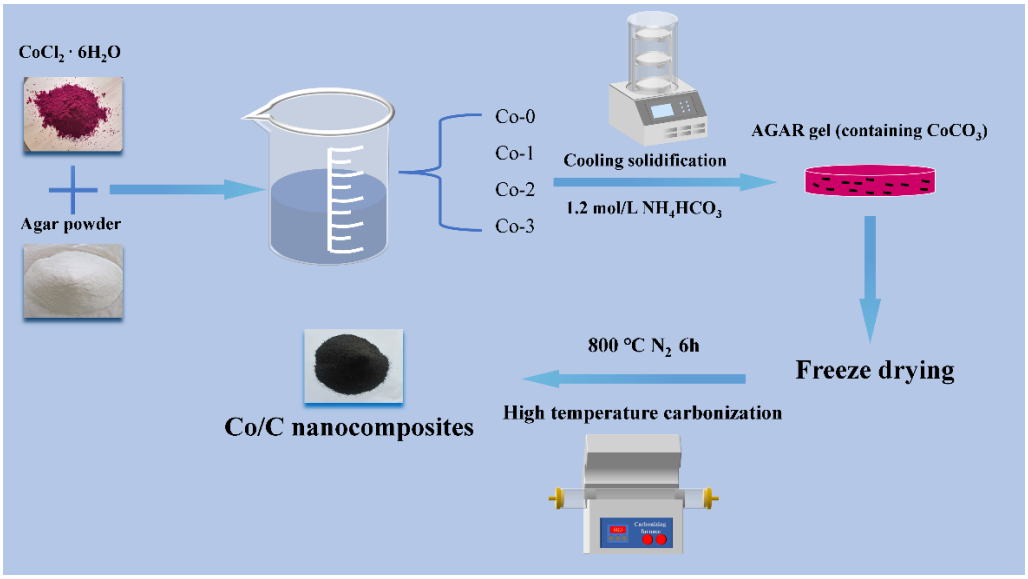

Fig. S1. Schematic diagram of the fabrication process of the Co/C nanocomposites.

1.2 Characterization of cobalt/carbon nanoparticles

The microstructure of the sample was investigated by field emission scanning electron microscopy (FE-SEM, JSM-7800F, JEOL) and energy-dispersive X-ray spectroscopy (EDS). The crystal structures of the samples were characterized by X-ray diffraction (XRD, Rigaku D Max 2500 VB) in the range of 2θ (10° ~ 90°). A micro-Raman spectrometer (Jobin Yvon HR800, France) was used to collect the Raman spectra of 532.05 nm incident radiation. The Fourier transform infrared spectroscopy (FT-IR) of Co/C nanocomposites was obtained in the range of 500 ~ 4000 cm^{-1}. (Vector 22, plus attenuation of total reflection attachment). Tamakawa TM-VSM2014-MHR (vibrating sample magnetometer) was used to evaluate the hysteresis loop of Co/C nanocomposites at room temperature. The Co/C powder was evenly dispersed in paraffin at different mass ratios and pressed into a ring sample with an inner diameter of 3.01 mm and an outer diameter of 6.99 mm. Using vector network analyzer (VNA,

Agilent N522A), the dielectric constant and permeability were obtained in transmission/reflection mode over the frequency range of 2-18 GHz. Finally, we use the following formula to calculate the reflection loss (RL):

$$Z_{in}=Z_0\left(\mu_r/\varepsilon_r\right)^{1/2}\tanh\left\{j\left(2\pi f\,d/c\right)\left(\mu_r/\varepsilon_r\right)^{1/2}\right\} \quad (1)$$

$$\mathrm{RL(dB)}=20\lg\left|(Z_{in}-Z_0)/(Z_{in}+Z_0)\right| \quad (2)$$

where j means the unreliable number, f is the frequency of EM wave, d is the thickness of paraffin composite, and c is the light velocity in vacuum.

2. SEM supplementary images

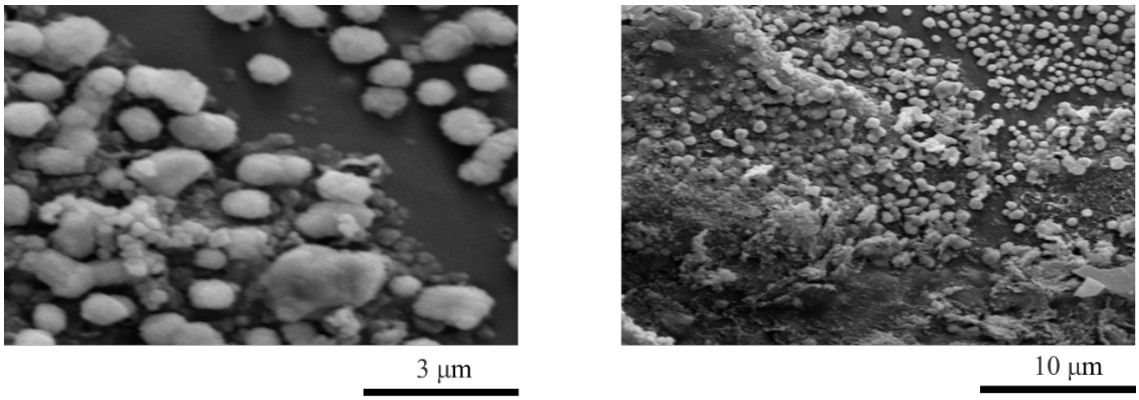

Fig. S2. SEM images of the Co/C nanocomposites.