Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting Information

Microwave-assisted foaming and sintering to prepare lightweight high-strength polystyrene/carbon nanotubes composite foams with an ultralow percolation threshold

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Closely resemble to the 3D filler network, a power-law equation was used here to anticipate the relationship between electrical conductivity and EG loading[1].

$$\sigma = \sigma_0(\varphi - \varphi_c)^t \quad (\varphi > \varphi_c) \tag{1}$$

where σ represents the conductivity, σ_0 is a constant reflects the intrinsic conductivity of CNTs, φ is the volume fraction of CNTs, φ_c is the percolation threshold, and t is a critical exponent revealing the dimensionality of the conductive networks. Find the logarithm of both sides of formula (1) with the natural logarithm as the base and fit in origin.

$$ln\sigma = ln\sigma_0 + tln(\varphi - \varphi_c) \quad (\varphi > \varphi_c) \tag{2}$$

The scattering parameters (S11 and S21) of samples were gathered to calculate the power coefficients absorption (A), reflection (R) and transmission (T) and EMI SE depending on the following equations:

$$R = |S_{11}|^2 \tag{3}$$

$$T = |S_{21}|^2 \tag{4}$$

$$A = 1 - R - T \tag{5}$$

$$SE_A = -10log(T/(1-R)) \tag{6}$$

$$SE_R = -10log(1-R) \tag{7}$$

$$EMI\ SE = SE_A + SE_R + SE_M \tag{8}$$

where the EMI SE is the summation of the reflection shielding (SE_R), the absorption shielding (SE_A) and the multiple reflections shielding (SE_M), the SE_M can be neglected while the SE_{total} > 10 dB.[2]

Generally, δ represents the depth at which the intensity of the irradiation inside the materials decreases to 1/e of its original value at the surface, and it determines the SE_A with a fixed thickness (*d*) of the material. The absorption effectiveness and skin depth (frequency dependence) according to the classical electromagnetic theory are reported by these following equations[1]:

$$SE_A = 20\frac{d}{\delta}loge \tag{9}$$

Where the *d* is 2 mm and the e is natural logarithm.

$$\delta = \frac{1}{\sqrt{\pi f \mu_0 \mu_r \sigma_S}} \tag{10}$$

where *f* and σ_S represent the frequency and AC electrical conductivity, respectively. μ_0 equals to $4\pi \times 10^{-7}\,H/m$, μ_r is the shield's relative magnetic permeability. For nonmagnetic materials, $\mu_r = 1$.[3]

Table S1. The optimal microwave parameters for coated EPS/CNTs beads

Filler content (wt%)	microwave power (W)	irradiation time (s)
0.04	800	60
0.06	700	60
0.08	600	60
0.1	500	60
0.15	400	60
0.2	300	60
0.3	300	50
0.4	300	40
0.5	300	30
0.75	300	25
1	300	20
1.5	300	12
2.0	300	8

Reference

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