Excellent electromagnetic (EM) wave absorbers with the whole X band absorption (8.2~12.4 GHz) that is resulted from attenuation ability instead of destructive interference is urgently needed, but still remains challenging. Here, a new EM absorption model named A/B/C is designed through introducing ZnO nanoparticles onto mesoporous carbon hollow microspheres (PCHMs@ZnO) via hydrothermal synthesis followed by annealing process. The controlled interface evolution associated with abundant heterogeneous interfaces play a crucial role in adjusting the Debye relaxation process, resulting in an optimized impedance matching and enhanced interfacial polarization loss. Through this way, targeted EM absorbers with excellent absorption ability which derives mainly from polarization loss rather than destructive interference are successfully obtained. The effective absorption bandwidth (EAB) of resultant PCHMs@ZnO absorbers annealed at 700 °C covers the whole X band and the mean value of reflection coefficient (RC) reaches -12 dB exceeding that of most of ZnO-based absorbers. The thickness range of RC < -8 dB can be up to 1 mm (from 3.3 mm to 4.3 mm), indicating a stable performance to the variation of sample thickness. This work provides a promising model for preparing high-performance EM absorbers.

**Keywords:** dielectric properties; interfaces; polarization; zinc oxide; destructive interference; carbon