Direct growth of defective carbon nanotubes with tunable dielectric properties in porous $Sc_2Si_2O_7$ ceramic for broadband high-performance microwave absorption

Hanjun Wei, Xiaowei Yin

Science and Technology on Thermostructural Composite Materials Laboratory,

Northwestern Polytechnical University, 710072, Xi'an, China

Abstract:

High-performance carbon nanotubes (CNTs) with adjustable electro-conductivity are widely used as electromagnetic (EM) waves absorption materials to achieve stealth of weapons and equipment and EM protection of living organisms. A simple technique for the preparation of CNTs/$Sc_2Si_2O_7$ ceramics is chemical vapor deposition (CVD) technology on porous $Sc_2Si_2O_7$ matrix. As expected, well-matched impedance and EM dissipation of CNTs/$Sc_2Si_2O_7$ ceramics are synthesized as we adjust the reaction time. Curls of CNTs form a three-dimensional network structure and accumulate interfaces, resulting in multiple reflections and scattering of EM waves. The defects and diameter of CNTs can also be optimized for reaction times. The existing defects will produce dipole polarization and affect the band gap of CNTs as well. The results show that the appropriate defects and diameter of CNTs will increase the band gap and regulate the conductivity loss of CNTs/$Sc_2Si_2O_7$. Hence, the excellent microwave absorption performance of CNTs/$Sc_2Si_2O_7$ (loading content of 1.56 wt.%) is RC_{min} of -33.5 dB at the thickness of 2.85 mm, achieving an effective absorbing bandwidth (EAB) of 4.2 GHz covering the whole X-band. The exploration results provide a useful reference to EM wave absorption materials with strong absorption, wide bandwidth and thin thickness.

Keywords: Defects, Microwave absorption properties, CNTs/$Sc_2Si_2O_7$ ceramics