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An investigation of microstructural, magnetic and microwave absorption properties of multi-walled carbon nanotubes/ $Ni_{0.5}Zn_{0.5}Fe_2O_4$

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The enhancement of microwave absorbing properties in nickel zinc ferrite ($Ni_{0.5}Zn_{0.5}Fe_2O_4$) via multiwall carbon nanotubes (MWCNT) growth is studied in this research work. $Ni_{0.5}Zn_{0.5}Fe_2O_4$ was initially synthesized by mechanical alloying followed by sintering at 1200 °C and the microstructural, electromagnetic and microwave characteristics have been scrutinized thoroughly. The sintered powder was then used as a catalyst to grow MWCNT derived from chemical vapor deposition (CVD) method. The sample was mixed with epoxy resin and a hardener for preparation of composites. The composite of multi-walled carbon nanotubes/$Ni_{0.5}Zn_{0.5}Fe_2O_4$ shown a maximum reflection loss (*RL*) of −19.34 dB at the frequency and bandwidth of 8.46 GHz and 1.24 GHz for an absorber thickness of 3 mm for losses less than −10 dB. This acquired result indicates that multi-walled carbon nanotubes/$Ni_{0.5}Zn_{0.5}Fe_2O_4$ could be used as a microwave absorber application in X-band.

The high magnetic permeability, high resistivity and low eddy current loss of nickel zinc ferrite ($Ni_{0.5}Zn_{0.5}Fe_2O_4$) in the high-frequency region has made them an important candidate in soft magnetic material. One of the significant applications of this ferrite in the high frequency region is its high potential EM wave absorption properties. $Ni_{0.5}Zn_{0.5}Fe_2O_4$ exhibit good microwave absorbing performance due to its comparative properties to other ferrite[1,2]. Nevertheless, high density and poor temperature stability bound its application as a material for radar absorber in stealth aircraft and other ranges[3]. Recently, various efforts to develop microwave absorbing material in lower dimension have also been undertaken by many researchers to meet the requirements of microwave absorption applications by summarizing the structure and electronic state of 2D materials, and comprehensively overview their electromagnetic properties and response mechanisms[4–7]. As for carbon nanotubes (CNTs) which possess greater surface area and more dangling bonds causing an interfacial polarization and macroscopic quantum tunnel effect, have shown potential microwave absorbing performance[8]. Besides, the lightweight, good heat, corrosion and thermal shock resistance, higher thermal and electrical conductivity of CNTs advantage them as an auspicious candidate for advanced composite usage[9–11]. Previous research has shown that various percent of CNT introduction into soft and hard ferrite via sol-gel method, *in situ* precipitation, hydrothermal and *in situ* solvothermal has significantly improved the microwave absorption characteristics. The introduction of CNT into ferrite samples also has increased the conductivity[12–16]. In the present research work, multi-walled carbon nanotubes/$Ni_{0.5}Zn_{0.5}Fe_2O_4$ was synthesized using chemical vapour deposition (CVD) by using sintered $Ni_{0.5}Zn_{0.5}Fe_2O_4$ powder as a catalyst to investigate the impact of hybridization between magnetic and dielectric part towards the electromagnetic and microwave properties of the composite.

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