DISSERTATION INFORMATION

Title: Study on super-paramagnetic $Zn_{0.8}Ni_{0.2}Fe_2O_4$ nanoparticles apply in microwave absorbing materials in the X band frequency range.

Major: Materials engineering

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ABSTRACT

Super-paramagnetic Fe-Zn-Ni nanoparticles open the application in military, especially in radar absorbing materials. Super-paramagnetic $Zn_{0.8}Ni_{0.2}Fe_2O_4$ ferrite nanoparticles were synthesized by hydrothermal method with oleic acid presence and temperature investigation were 120, 140, 160 and 180^{o}C in 6 hours. Super-paramagnetic $Zn_{0.8}Ni_{0.2}Fe_2O_4$ ferrite nanoparticles heated at 140^{o}C in 6 hours were then covered by SiO_2 layers to prevent the agglomeration, this ensured the Super-paramagnetic state of nanoparticles. Based on super-paramagnetic $Zn_{0.8}Ni_{0.2}Fe_2O_4$ ferrite nanoparticles, proceed to fabricate the microwave absorbing samples involves super-paramagnetic $Zn_{0.8}Ni_{0.2}Fe_2O_4$ ferrite nanoparticles covered by SiO_2 layers ($Zn_{0.8}Ni_{0.2}Fe_2O_4/SiO_2$), carbon black nanoparticles and epoxy resin, then, test their reflection loss to calculate the microwave absorption in the X band frequency range (8-12 GHz). All of microwave absorbing samples were investigated the effect of content, super-paramagnetic state of super-paramagnetic $Zn_{0.8}Ni_{0.2}Fe_2O_4$ ferrite nanoparticles and microwave absorbing thickness on microwave absorbing ability in the X band frequency range (8-12 GHz).

In this research, we used X-ray diffractometer (XRD), Transmission Electron Microscopy (SEM), Scanning Electron Microscope (TEM), using vibrating sample magnetometer (VSM), Fourier transform infrared (FTIR), and using reflection loss measurement in full electromagnetic absorption room.

The results showed the ferritization were completely occurred from 140, 160 and 180°C hydrothermal temperature, the average size corresponding to approximate 5.00; 7.50 and 8.00 nm, saturation magnetization M_s were increased from 25.39 to 27.12 emu/gr, all of nanoparticles reached to super-paramagnetic state with remanence M_r, coercivity H_c were approximately zero values. This study indicated that the increase 0.5 to 1.5% of super-paramagnetic $Zn_{0.8}Ni_{0.2}Fe_2O_4$ ferrite nanoparticles content led to the increase of microwave absorption in the range of 9-11 GHz and reached to 98.8% highest value at 10 GHz, higher of microwave absorbing thickness led to greater microwave absorption from 82.8 to 98.8% at 10 GHz, the result also demonstrated that the microwave-absorbing ability of the sample containing super-paramagnetic $Zn_{0.8}Ni_{0.2}Fe_2O_4$ reached to 98.8% was greater than that of the sample with multidomain $Zn_{0.8}Ni_{0.2}Fe_2O_4$ (73.5%).

Novel contributions of dissertation:

- Superparamagnetic ferrite nanoparticles with composition $Zn_{0.8}Ni_{0.2}Fe_2O_4$ were successfully synthesized at hydrothermal treatment temperatures of 140°C to 180°C, this opened the ability of applying superparamagnetic $Zn_{0.8}Ni_{0.2}Fe_2O_4$ ferrite nanoparticles into military field.

- X band frequency microwave-absorbing mixtures based on superparamagnetic $Zn_{0.8}Ni_{0.2}Fe_2O_4$ ferrite nanoparticles was successfully fabricated, reached to highest absorption (98.8%) of 2 mm thickness.

- The research indicated that higher of superparamagnetic $Zn_{0.8}Ni_{0.2}Fe_2O_4$ ferrite nanoparticles content from 0.5 to 1.5% led to higher microwave absorbing ability, the disparity of microwave absorption between sample contains superparamagnetic $Zn_{0.8}Ni_{0.2}Fe_2O_4$ ferrite nanoparticles and $Zn_{0.8}Ni_{0.2}Fe_2O_4$ ferrite nanoparticles, the increase of microwave absorption when microwave thickness increased from 0.5 to 2 mmm in the X band frequency range (8-12 GHz).

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