

## INTISARI

### Kajian Struktur Kristal dan Sifat Kemagnetan pada Nanopartikel Zink Nickel Ferrite ( $Zn_{0,5}Ni_{0,5}Fe_2O_4$ ) yang Dienkapsulasi dengan Silika dan *Polyethylene Glycol* (PEG-4000)

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Nanopartikel  $Zn_{0,5}Ni_{0,5}Fe_2O_4$  dengan struktur mixed spinel telah berhasil disintesis menggunakan metode kopresipitasi dan dienkapsulasi dengan variasi konsentrasi silika dan PEG-4000. Hasil *X-Ray diffraction* (XRD) menunjukkan nanopartikel  $Zn_{0,5}Ni_{0,5}Fe_2O_4$  mempunyai ukuran 15,23 nm. Setelah dienkapsulasi menggunakan silika dan PEG-4000 ukuran kristalit turun menjadi 14,13 nm dan 13,26 nm. Hasil *Transmission Electron Microscopy* (TEM) menunjukkan nanopartikel masih mengalami aglomerasi setelah dienkapsulasi silika dan PEG-4000. Hasil dari *Vibrating Sample Magnetometer* (VSM) menunjukkan nilai koersivitas  $Zn_{0,5}Ni_{0,5}Fe_2O_4$  adalah 50,7 Oe. Koersivitas pun turun setelah dienkapsulasi dengan silika dan PEG-4000 menjadi 45,2 Oe dan 47,9 Oe. Hal ini disebabkan karena penurunan ukuran kristalit. Magnetisasi saturasi  $Zn_{0,5}Ni_{0,5}Fe_2O_4$  adalah 18,4 emu/g. Setelah dienkapsulasi dengan silika magnetisasi saturasi turun menjadi 16,8 emu/g dikarenakan silika mempunyai sifat non-magnetik. Setelah dienkapsulasi menggunakan PEG-4000 magnetisasi saturasi turun menjadi 17,1 emu/g dikarenakan PEG mempunyai sifat paramagnetik. Hasil *Fourier Transform Infra Red* (FTIR) untuk  $Zn_{0,5}Ni_{0,5}Fe_2O_4$  menunjukkan puncak serapan disekitar 300-600  $cm^{-1}$  yang merupakan ikatan vibrasi M-O. Setelah dienkapsulasi dengan silika muncul ikatan vibrasi baru khas silika berupa Si-O-Si (1087,85  $cm^{-1}$ ), Si-OH (794,67  $cm^{-1}$ ), dan Si-O-Fe (574,64  $cm^{-1}$ ). Sedangkan ketika dienkapsulasi dengan PEG-4000 muncul vibrasi baru khas PEG yaitu C-O (1064,71  $cm^{-1}$ ). Pada kedua enkapsulasi ikatan M-O masih tetap muncul yang menandakan kehadiran  $Zn_{0,5}Ni_{0,5}Fe_2O_4$ .

**Kata Kunci:** Zink Nickel Ferrite ( $Zn_{0,5}Ni_{0,5}Fe_2O_4$ ), kopresipitasi, enkapsulasi, silika, PEG-4000.

## ABSTRACT

### ***CRYSTAL STRUCTURES AND MAGNETIC PROPERTIES OF POLYETHYLENE GLYCOL (PEG-4000) AND SILICA ( $SiO_2$ ) ENCAPSULATED ZINK NIKEL FERRITE ( $Zn_{0.5}Ni_{0.5}Fe_2O_4$ ) NANOPARTICLES***

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Nanocrystalline mixed spinel ferrite of  $Zn_{0.5}Ni_{0.5}Fe_2O_4$  nanoparticles has been successfully synthesized by coprecipitation method and encapsulated by silica and PEG-4000 with various concentrations. X-Ray Diffraction (XRD) patterns showed that nanoparticles contained  $Zn_{0.5}Ni_{0.5}Fe_2O_4$  spinel ferrite with particles size of 15.2 nm. After silica encapsulation the new phase of  $SiO_2$  appearance and the particles size became 14.1 nm. After PEG-4000 encapsulation also appeared a new phase of  $\alpha - FeO(OH)$  and the particles size became 13.3 nm. Transmission Electron Microscopy (TEM) image showed that the nanoparticles also agglomeration after silica and PEG-4000 encapsulation. The coercivity ( $H_c$ ) of  $Zn_{0.5}Ni_{0.5}Fe_2O_4$  was 50,7 Oe. The  $H_c$  decrease after silica and PEG-4000 encapsulation became 45,2 Oe and 47.9 Oe, respectively. It is due to the decrease of particle size. The saturation magnetization ( $M_s$ ) of  $Zn_{0.5}Ni_{0.5}Fe_2O_4$  was 18.4 emu/g, and decrease to 16.8 emu/g after silica encapsulation because  $SiO_2$  is diamagnetic.  $M_s$  decrease to 17.1 emu/g after PEG-4000 encapsulation. This is because PEG-4000 has paramagnetic properties. Fourier Transform Infra Red (FTIR) spectra for  $Zn_{0.5}Ni_{0.5}Fe_2O_4$  show that the absorption peaks is around 300-600  $cm^{-1}$  which is an M-O bond vibration. After a silica encapsulation, there are new bond vibration typical of silica like Si-O-Si (1087.85  $cm^{-1}$ ), Si-OH (794.67  $cm^{-1}$ ), and Si-O-Fe (574.64  $cm^{-1}$ ). The PEG-4000 encapsulation has new vibration for typical of PEG like C-O (1064.71  $cm^{-1}$ ). Both of encapsulation has M-O bond vibration indicates the presence of  $Zn_{0.5}Ni_{0.5}Fe_2O_4$  nanoparticles.

**Keyword:** Zink Nickel Ferrite ( $Zn_{0.5}Ni_{0.5}Fe_2O_4$ ) magnetic nanoparticles, coprecipitation, encapsulation, silica and PEG-4000