

INTISARI

PENGEMBANGAN LABEL MAGNETIK *GREEN-SYNTHESIZED* FEROFLUIDA Fe₃O₄ BERBASIS MINYAK JARAK UNTUK SENSOR *GIANT MAGNETORESISTANCE*

Oleh

Rahma Ayu Aliefia Aini Ulil Albab

22/503062/PA/21602

Penelitian ini melaporkan keberhasilan sintesis ferrofluida Fe₃O₄ berbasis minyak jarak menggunakan metode *green synthesis* (ekstrak *Moringa oleifera*) dan pelapis asam oleat. Karakterisasi difraksi sinar-X menunjukkan nanopartikel memiliki struktur *face-centered cubic invers spinel* dengan ukuran kristalit sebesar $(10,10 \pm 0,09)$ nm dan parameter kisi sebesar $(8,15 \pm 0,06)$ Å. Analisis *fourier transform infra-red* mengonfirmasi terbentuknya ferrofluida Fe₃O₄ dengan munculnya gugus fungsi Fe–O (inti magnetit), C=O dan O–H (minyak jarak), serta COO⁻ (asam oleat). Hasil karakterisasi *vibrating sample magnetometer*, nanopartikel Fe₃O₄ menunjukkan sifat *soft ferromagnetic* dengan nilai magnetisasi saturasi (*Ms*) 55,3 emu/g, magnetisasi remanensi (*Mr*) $(11,9 \pm 0,3)$ emu/g, dan koersivitas (*Hc*) $(54,91 \pm 0,06)$ Oe. Pengujian label magnetik pada sensor GMR AAL024 menunjukkan bahwa peningkatan konsentrasi ferrofluida (5, 10, 15, 20 mg/mL) menghasilkan kenaikan respon tegangan keluaran. Selain itu, diperoleh nilai sensitivitas sebesar 3,94 mV/(mg/mL), linearitas $R^2 = 0,99$, dan batas pendeteksian sebesar 0,4 mg/mL.

Kata kunci : Ferrofluida Fe₃O₄, *Giant magnetoresistance*, *Green synthesis*, Label magnetik

ABSTRACT

DEVELOPMENT OF A GREEN-SYNTHESIZED Fe₃O₄ FERROFLUID MAGNETIC LABEL BASED ON CASTOR OIL FOR GIANT MAGNETORESISTANCE SENSORS

By

Rahma Ayu Aliefia Aini Ulil Albab

22/503062/PA/21602

This study reports the successful synthesis of Fe₃O₄ ferrofluid based on castor oil using the green synthesis method with *Moringa oleifera* extract and oleic acid as a surfactant. X-ray diffraction characterization confirmed that the nanoparticles possess an inverse spinel face-centered cubic structure with a crystallite size of (10.10 ± 0.09) nm and a lattice parameter of (8.15 ± 0.06) Å. Fourier-transform infrared analysis verified the formation of Fe₃O₄ ferrofluid through the presence of Fe–O (magnetite core), C=O and O–H (castor oil), and COO⁻ (oleic acid) functional groups. Based on vibrating sample magnetometer characterization, the Fe₃O₄ nanoparticles exhibited soft ferromagnetic behavior, with a saturation magnetization (*Ms*) of 55.3 emu/g, remanent magnetization (*Mr*) of (11.9 ± 0.3) emu/g, and coercivity (*Hc*) of (54.91 ± 0.06) Oe. Magnetic label testing using the GMR AAL024 sensor demonstrated that increasing the ferrofluid concentration (5, 10, 15, 20 mg/mL) resulted in a higher output voltage response. Furthermore, the system achieved a sensitivity of 3.94 mV/(mg/mL), linearity of $R^2 = 0.99$, and a limit of detection of 0.4 mg/mL.

Keyword : Fe₃O₄ ferrofluid, Giant magnetoresistance, Green synthesis, Magnetic label