INTISARI

DETEKSI BIOMOLEKUL MENGGUNAKAN SENSOR *GIANT MAGNETORESISTANCE* (GMR) BERBASIS LAPISAN TIPIS *SPINVALVE* CoFeB DENGAN RANGKAIAN JEMBATAN WHEATSTONE

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Dalam penelitian ini, sensor giant magnetoresistance (GMR) berbasis lapisan tipis *spin-valve* CoFeB dengan rangkaian jembatan *wheatstone* telah berhasil dikembangkan untuk mendeteksi formalin dan gelatin dari kulit sapi (bovine-skin) dan kulit babi (porcine-skin). Lapisan tipis dengan struktur *spin-valve* [IrMn(10 nm)/CoFe(3 nm)/Cu(2.2 nm)/CoFeB(10 nm)] yang difabrikasi dengan metode *DC magnetron sputtering* dipilih sebagai *magnetic sensing surface*, dengan magnetoresistansi sebesar 6%. Nanopertikel Fe_3O_4 sebagai partikel label (nanotag) disintesis dengan metode kopresipitasi. Pola *X-ray diffraction* (XRD) dan gambar *transmission electron microscopy* (TEM) menunjukkan bahwa Fe_3O_4 memiliki struktur invers spinel, memiliki butir bulat yang seragam dengan ukuran sekitar 20 nm. *Hysterisis loop* dari *vibrating sample magnetometer* (VSM) menunjukkan bahwa Fe_3O_4 memiliki sifat *soft* magnetik dengan magnetisasi saturasi (*Ms*), magnetisasi remanen (*Mr*) dan koersifitas (*Hc*) masing-masing sebesar 77.2 emu/g, 7.8 emu/g 51,2 Oe. Nanopartikel Fe_3O_4 difungsionalisasi dengan polyethylene-glycole (PEG)-4000 dengan konsentrasi 20%, 25%, 33,3% dan 50%. Fungsionalisasi ini bertujuan agar nanopartikel label dapat berikatan dengan biomolekul. Deteksi biomolekul seperti formalin dan gelatin dari kulit sapi (*bovine-skin*) dan kulit babi (*porcine-skin*) (konsentrasi 1%, 3%, 5%, and 7%) didispersi dalam ethanol pada suhu kamar. Arus DC 10 mA dan variasi medan magnet eksternal sebesar 0-650 Gauss diberikan pada lapisan tipis. Medan induksi dari nanopartikel magnetik menyebabkan perubahan tegangan keluaran sensor dengan maksimum delta tegangan keluaran sebesar 6.414 mV (20%) untuk deteksi Fe_3O_4/PEG dan minimum delta tegangan keluaran sebesar 4.937 mV (10%) untuk deteksi formalin, 2.268 mV (7%) untuk deteksi gelatin sapi dan 2.943 mV (7%) untuk deteksi gelatin babi. Delta tegangan keluaran merupakan selisih antara tegangan keluaran dengan dan tanpa medan magnet eksternal 650 Gauss. Delta tegangan keluaran sensor berbanding terbalik dengan konsentrasi PEG-4000, formalin, gelatin sapid an gelatin babi. Adanya perubahan tegangan keluaran sensor mengindikasikan bahwa sensor GMR berbasis lapisan tipis *spin-valve* dengan rangkaian jembatan *wheatstone* berpotensi sebagai biosensor.

Keywords: Biosensor, Nanopartikel Fe_3O_4, *Giant Magnetoresistance* (GMR), Jembatan Wheatstone

ABSTRACT

BIOMOLECULE DETECTION USING WHEATSTONE BRIDGE GIANT MAGNETORESISTANCE (GMR) SENSORS BASED ON CoFeB SPIN-VALVE

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In this study, a potential wheatstone bridge giant magnetoresistance (GMR) biosensor was successfully developed for detection of formalin and gelatin from bovine-skin and porcine-skin. [IrMn(10 nm)/CoFe(3 nm)/Cu(2.2 nm)/CoFeB(10 nm)] spin-valve structures has been chosen as the magnetic sensing surface, showing a magnetoresistance of 6%% fabricated by DC magnetron sputtering method. The Fe_3O_4 magnetic nanoparticles as biomolecular labels (nanotags) was synthesized by co-precipitation method. The X-ray diffraction (XRD) patterns and transmission electron microscopy (TEM) images showed that Fe_3O_4 was well crystallized and grew in their inverse spinel structure, highly uniform morphology with average grain size was about 20 nm. Hysterisis loop from vibrating sample magnetometer (VSM) shows that Fe_3O_4 was soft magnetic behavior with saturation magnetization (*Ms*), remanent magnetization (*Mr*) and coercivity (*Hc*) is 77.164 emu/g, 7.846 emu/g and 0.051 kOe, respectively. Fe_3O_4 was coated with polyethylene-glycole (PEG)-4000 with concentration 20%, 25%, 33.3% and 50% for surface functionalization. This functionalization was intended to capture biomolecules. Detection of biomolecule such as formalin (2%, 4%, 6%, 8%, and 10%), gelatin from bovine-skin and porcine-skin (1%, 3%, 5%, and 7%) were dispersed in ethanol at room temperature. 10 mA DC current was applied to the circuit. Various applied magnetic fields of 0-650 Gauss have been performed using electromagnetic with various current 0-5A. Induction would cause a shift in output voltage with maximum delta output voltage 6.414 mV (20%) for PEG-coated Fe_3O_4 and minimum delta output voltage 4.937 mV (10%) for formaldehyde detection, 2.268 mV (7%) for bovine-skin gelatin and 2.943 mV (7%) for porcine-skin gelatin detection. The delta output voltage was differences between output voltage without and with 650 gauss external magnetic field. The delta output voltage of wheatstone bridge in real time measurement was linear to the mass ratio of Fe_3O_4 but in biomolekul detection, the delta output voltage was decrease by increase in the concentration of formalin, gelatin from bovine-skin and porcine-skin The change of delta output voltage indicate that the spin-valve thin film with wheatstone bridge circuit is potential as a biosensor.

Keywords: Biosensors, Fe_3O_4 magnetic nanoparticles, Giant magnetoresistance (GMR), wheatstone bridge circuit