# Analysis of Red Blood Cell by Using a Highly Sensitive GMR-Spin Valve Film Device and μ-Coil and Channel

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The giant magnetoresistance(GMR)-spin valve(SV) device having a high linearity and a low hysteresis for was developed by the biosensor to analyze the detection property of red blood cell(RBC). The properties for the dual-type GMR-SV film as glass/Ta/NiFe/Cu /NiFe/FeMn or IrMn/NiFe/Cu/NiFe/Ta include a magnetoresistance ratio (MR) of 8.5%-10.0%, a magnetic sensitivity (MS) of 1.0%/Oe -1.5%/Oe, and a coercivity of 1.0 Oe-1.5 Oe for the free NiFe layer applying to the artificial isotropic magnetic property in-plane of film. The multuilayer structure with in-plane orthogonal easy axes controlled by the post annealing temperature of 105°C was included of the free and the pinned ferromagnetic layers for applying biosensor. The RBC coupled to the magnetic beads can be captured on the 10 turn μ-coils, which maintain an enough magnitude of magnetic field for the detection of magnetic beads attached to RBC. When RBCs coupled to several magnetic beads passed on the micro channel with a diameter of a few μm, the movement of those is controlled by the electrical AC input signal applied to the 10 turn μ-coils. The RBCs captured above the GMR-SV device are changed as the output signals for detection status. It implies that this device as biosensor can analyze the coupling force between hemoglobin and magnetic beads for the deformed features of RBCs to pass the narrow capillary. Also, the dual-type GMR-SV device and μ-coil and channel can be applied to analyze a new property of the membrane's deformation of RBC coupled to magnetic beads.

## 1. Experiments

The coil-channel-composite structure for a modular device was of a type for controlling it as it flows along with the biomolecule passage of red blood cells in the micron size. The first substrate Corning glass (#7059) was deposited over the thin-film GMR-SV. First the photolithographic process and ECR-ion milling process through the width and length are respectively 1 μm and a size of 20 μm was produced gateun GMR-SV devices. Through a second photolithography process to pattern the electrode made of Cu GMR-SV electrode element for the biosensor. Developed GMR-SV Bio edge devices other than the center portion of the electrode material of all PR was coated only on the $SiO_2$ insulating layer while leaving a thin film by rf sputtering method. GMR-SV μ- coil electrode so that the electrode passageway and passage is not connected to each other of the insulating layer was deposited by 100 nm thick $SiO_2$ thin film by rf sputtering. After each step lithography process for forming a composite structure, the actual shape of the patterning results showed a photograph in Fig. 1. Fig. 1 is the actual shape of the coil wound μ- once patterned by lithography, the Cu thin film was coated on the substrate.

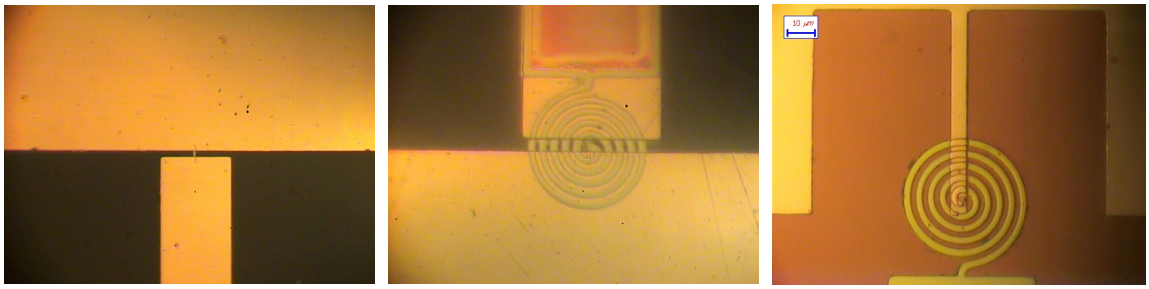

Fig. 1. Three steps of GMR-SV device with a size of 1×18 $\mu m^2$ with 10 turn μ-coils.

## 2. Results and Discussion

Fig. 2 shows that (a) real photograph of the motion of RBC + μBeads through out the PR channel above GMR-SV device; (b) visualization of the flow for a RBC + μBeads inside the PR μ-channel positioned on the center of GMR-SV device. A RBC +μBeads flows in three steps with moving (A), stop (B), and moving (C) controlled by using input AC ignal applied to one turn μ-coil. Fig. 3 shows that the response of the output signals for the input signals (a) Vpp = 200 mV : 20 kHz and (b) Vpp = 120 mV : 20 kHz. This input signal has enough amplitude and frequency, which is induced on RBC + μBeads and applied to one μ-coil.

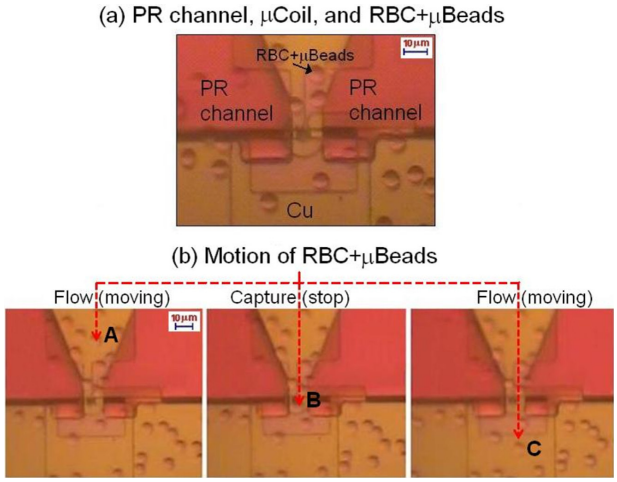


Fig. 2

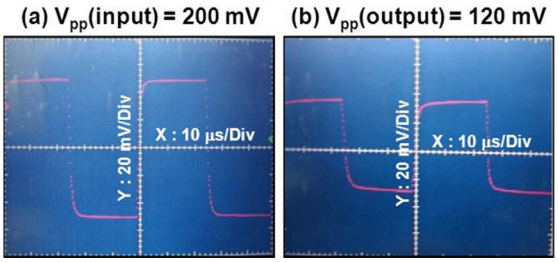


Fig. 3

## 3. References

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