Implementation of Linear Field Sensor utilizing Spin Transfer Torque-Magnetic Tunnel Junction

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The conventionally MR devices such as Giant magnetoresistance (GMR), Tunnel magnetoresistance (TMR) and spin transfer torque-magnetic tunnel junction (STT-MTJ) for memory can be shown character of a distinct bistable state for 0 and 1. There exist some crucial problems, when developing field sensor by using the MR devices, it has to be developed new structure and fabrication process to show the character of linear output [1-3]. However, in case of STT-MTJ, it does not need to change the structure or the process but the operating method modification can achieve to fulfill a condition of linear output.

In this study, the linear magnetic field sensor by using STT-MTJ is successfully implemented. Unlike MR sensors and Hall sensor, the figure of merit of STT-MTJ, areal density is higher than that of the conventional MR devices; more chips can be produced and manufacturing price can be reduced. Also it has a low power consumption and a high MR ratio about 100 % ; high sensitivity. The more MR ratio is higher, the more sensitivity is higher. We studied a MgO-based MTJ of the composition PtMn/CoFe/Ru/CoFeB/MgO/CoFeB [4]. The STT-MTJ devices have no linear feature and hysteretic, more likely step function depending on the magnetic field. So it is not appropriate for the magnetic field sensor. To solve these problems, bipolar pulse voltage is applied and the characteristic of linear output can be successfully obtained at critical bipolar pulse voltage (= 600 mV), as shown in Fig. 1. A possible origin of the dependence of a bipolar pulse response in STT-MTJ device will be discussed in detail.

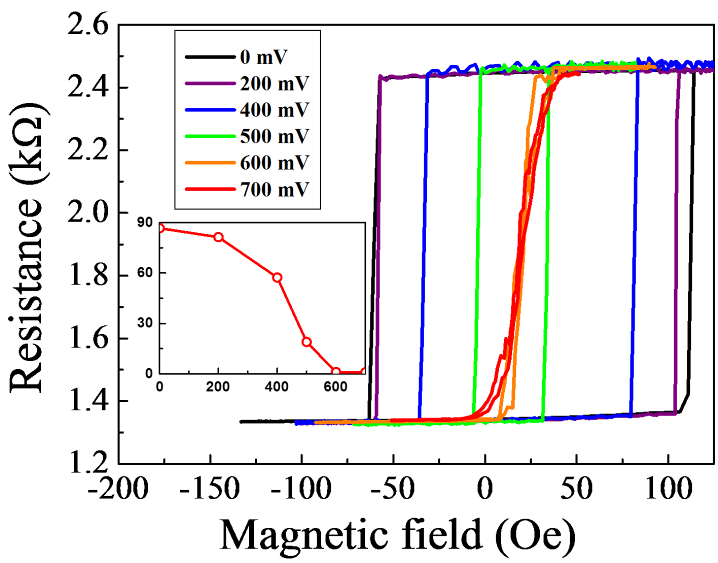

Fig. 1. Magnetic field dependence of resistance in STT-MTJ device. The coercivity of R-H loop decreases by increasing bipolar pulse voltage. Inset: The amplitude of bipolar pulse voltage-dependent coercivity.

References

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