S-16

Tunneling Magnetoresistance of a Ramp Edge Junction with $SrTiO_3$ Barrier Layer

SangJi University, Sang-Suk Lee, Young-Il Kim, Do-Guwn Hwang
Dankook University Sun-Wook Kim
Korea University, Kungwon Rhie, Sookmyung Women's University Jang-Roh Rhee

$SrTiO_3$ 장벽층을 이용한 경사형 모서리 접합의 터널링 자기저항 특성연구

상지대학교 이상석, 김영일, 황도근
단국대학교 김선욱
고려대학교 이긍원, 숙명여자대학교 이장로

A ramp-type tunneling magnetoresistance (TMR) junction having structure NiO(60 nm)/pinned Co(10 nm)/NiO(60 nm)/barrier $SrTiO_3$(2-10 nm)/free NiFe(10 nm) with the 15 degree slope was investigated. We obtained nonlinear *I(V)* characteristics for ramp-type tunneling junctions that have distinctive difference with and without applied magnetic field. In the barrier $SrTiO_3$ thickness of 4 nm, the TMR was about 52% at a bias voltage of 50 mV. The resistance and TMR dependence of bias votage in a ramp-type tunneling junction were similar with those of the layered TMR junction.

I. Introduction

Ramp-type junctions have several merits, such as a solvable boundary problem at the slope interface, usage of edge domain wall effects, and ease of scale down to the sub-micron range. In this study, we have fabricated ramp-type magnetic tunneling junctions with a $SrTiO_3$ barrier and have observed *I(V)* curves that exhibit anomalous high bias voltage dependence.

II. Experimentals

Firstly, a half PR-coated layer of a glass/NiO(60 nm)/Co(10 nm)/NiO(30 nm) trilayer is milled with an electron cyclotron resonance (ECR) Ar-ion miller. In order to avoid damage during the process, we etched at a low milling rate of 0.03 nm/sec. The detailed ECR milling condition is described elsewhere. After deposition of NiO and Co layers with rf and dc magnetic sputtering, respectively, the whole layers were milled at an angle of 15°. Then, $SrTiO_3$ tunneling barrier and NiFe top electrode were deposited with thickness of 2-10 nm and 10 nm, respectively. The final ramp-type junction was made, after the lift off process for electrodes. Figure 1(a) illustrates a cross section view of the ramp edge line from side. The height and the angle for the milled step are 250 nm and 15°, respectively. Figure 1(b) is the schematic of tunneling process with a $SrTiO_3$ barrier between the free NiFe layer and the wedge-pinned NiO/Co/$SrTiO_3$ layers. The experimental results will be discussed on the basis of Fig. 1(b). Fig. 1(c) is the schematic of a ramp-type structure for the measurement of *I(V)* and TMR curves.

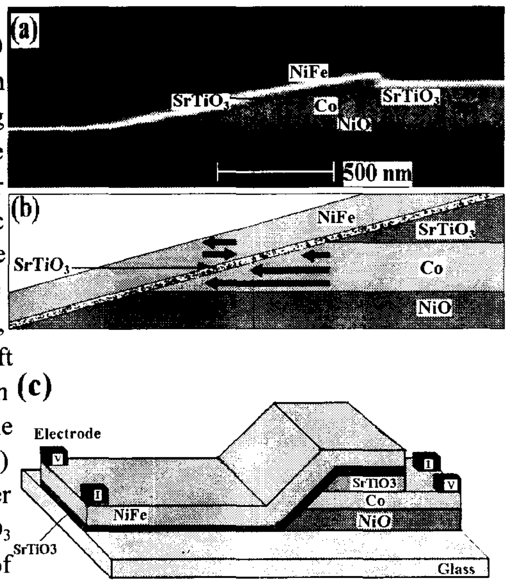

Figure. 1

III. Results and discussion

Figures 2(a) and (b) show *I(V)* characteristic curves of ramp-type tunneling junctions with the $SrTiO_3$ barrier thickness of 2 nm and 10 nm, respectively. Figure 3 presents a characteristic *I(V)* curve of a ramp-type tunneling junction with 4 nm thick $SrTiO_3$ tunneling barrier. In the case of zero field (H_a=0 Oe), we observed a nonlinear curve with tunneling junction resistance and junction area of about 2 MΩ~4 MΩ and about 0.5 μm^2, respectively, which is quite a similar value compared to that of a conventional Al_2O_3 based layer-by -layer magnetic tunnel junctions. *I(V)* curve is studied with an applied magnetic field (H_a=+500 Oe)

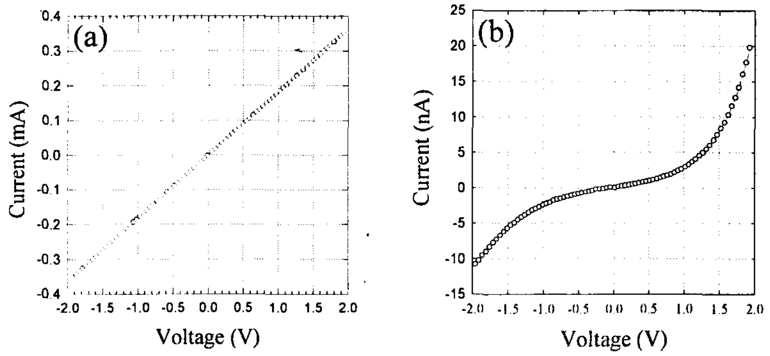

Figure 2.

perpendicular to the ramp edge line, still along the film plane. The *I(V)* characteristics are distinctly different from that of zero field bias. Both curves are nonlinear and bias field makes a lot of effect on the *I(V)* curve. The bias dependence of TMR can be drawn from Fig. 3, and it is presented in Fig. 4(a). The TMR amplitude is up to 52.7% at the bias voltage of 50 mV. This TMR value for a ramp-type tunneling junction is a very high. This high positive TMR value is compared with the other group's results for the spin inversion across tunnel junction using the $SrTiO_3$ barrier with negative TMR. Figure 4(b) is a typical TMR curve of the ramp-type junction with $SrTiO_3$ having a high positive TMR ratio of about 52.7% at applied bias voltage was -50 mV. The resistance and TMR dependence of bias votage in a ramp-type tunneling junction were similar with the recent results of the layered TMR junction.

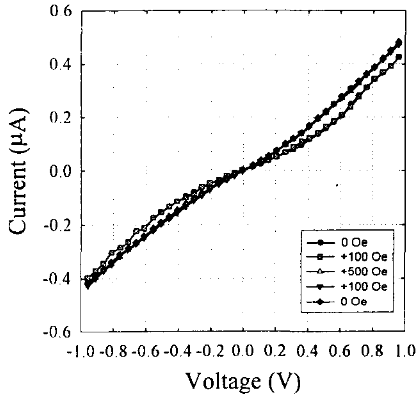

Figure 3.

Ⅳ. Conclusion

In conclusion, a ramp-type tunneling junction was fabricated and its transport properties were investigated. We presented the *I(V)* curves with and without applied field, which generated high TMR. The slightly asymmetric bias voltage dependence of TMR is observed, which indicates asymmetric spin-dependent tunneling process through the ramp edge. Detailed results will be discussed in another article.

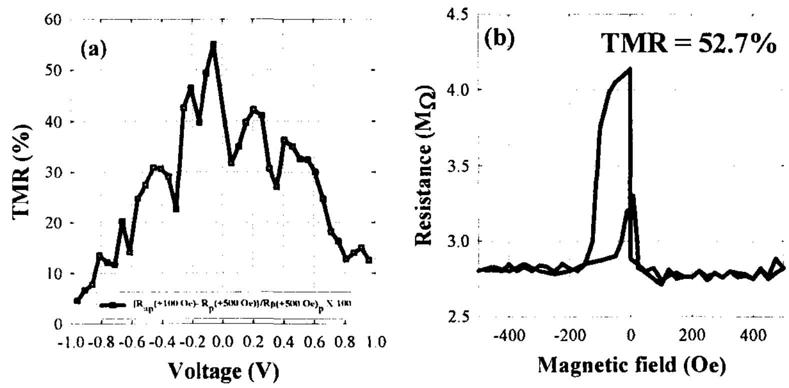

Figure 4.