Transfer ratio of magnetic tunnel transistor with different Schottky materials

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Several investigations have been carried out in the spin valve transistor (SVT) [1] and the magnetic tunnel transistor (MTT) [2][3]. For applications, an improvement of transfer ratio is necessary. In this work, an influence of Schottky materials on magnetic current(MC) and transfer ratio were investigated.

Two types of MTTs with different Schottky junctions were prepared as shown in Fig. 1. One is Al/Cu/AlO$_x$/2nm-Co/3.5nm-Cu/t nm-NiFe/nSi (ls-MTT), and another is Al/Cu/AlO$_x$/ 2nm-Co/3.5nm-Cu/t nm-NiFe/10nm-Au/nSi (hs-MTT), where t was varied from 2.0 to 8.0nm. All measurements were performed at 77 K.

Figure 2 shows the emitter voltage(V_E) dependence of the transfer ratio for ls- and hs-MTT indicated with circles and squares, respectively. Solid and open symbols represent the parallel and anti-parallel alignments of magnetization of magnetic layers, respectively. The collector currents begin to flow at V_E =0.60V for the ls-MTT and at V_E =0.80V for hs-MTT. It is reasonable to suppose that this difference result from that of the Schottky barrier height. The transfer ratios and MCs at V_E =1.00V were estimated to be 0.76×10^{-3} and 256% for the ls-MTT, 0.76×10^{-4} and 114% for the hs-MTT. Although the use of a lower Schottky barrier decreases the MC, it can improve the transfer ratio. In this work, the transfer ratio of ls-MTT becomes about 1 order of magnitude larger than that of hs- MTT. These results indicate that the transfer ratio is very sensitive to the Schottky barrier height and there is a relation of the trade-off between the transfer ratio and the MC. However, we have believed that the MC can be improved by using suitable magnetic materials, preserving the high transfer ratio.
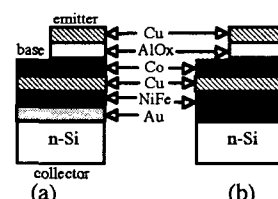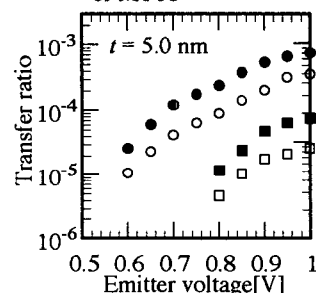

Fig.1 Schematic illustrations of MTTs

Fig.2 Dependence of transfer ratio on emiter voltage

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