We have investigated the temperature dependence of the MC and the transfer ratio for MTTs with different emitter materials (Co and NiFe). As temperature is decreased to 100K, the MC increases for both emitter materials. For the MTT with the NiFe/Al2O3 emitter, we obtain an MC of 104% at 100K, corresponding to a tunnel spin polarization of 34% at -900mV. The MTT with the Co emitter shows slightly weaker temperature dependence than that with a NiFe emitter. The temperature dependence of the MC does not change with emitter bias voltage, whereas the temperature dependence of the transfer ratio (Imax/Imin) does. The transfer ratio increases with increasing temperature for a bias just above the collector Schottky barrier height, while it decreases with temperature for larger bias.

We also examined the tunnel spin polarization of other ferromagnetic/insulator combinations using the MTT. We have modified the tunnel barrier by inserting SiO2 at the interface between the FM emitter and Al2O3 in order to probe the intrinsic tunnel spin polarization of the NiFe/SiO2 interface. By inserting 0.8nm of SiO2, the MC almost disappears. This indicates that the tunnel spin polarization of NiFe is drastically reduced in contact with SiO2.

Fig. 1. Schematic energy diagram (left) and the layer structure (right) of a lithographically defined MTT.

Fig. 2. Collector current versus magnetic field of a MTT with NiFe/Al2O3 emitter at room temperature. The magnetocurrent (MC) is 82% at an emitter bias of -900mV.