Direct-current induced resistance switching in nanocontacts Au tip - Fe/Si multilayer

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We have investigated a significant direct-current induced resistance switching processes in nanocontacts Au-tip – Fe/Si multilayer, with the DC current passing perpendicularly to the multilayer plane. These processes were studied at RT as a function of the current polarity and its density up to 100 MA/cm^2. These nanocontacts, which accommodates the necessary high current density for current-induced resistive switching effect (CIRS), was then made by pressing the Au wires (0.05 mm in diameter) onto surface multilayers - the Fe-top sublayer. Voltage (U) as a function of current (I) was measured using scanning values of current (the ramp speed about 10^{-6} A/sec) controlled by computer device. The polarity of the current was positive when the current was flowing from the tip to the multilayer.
The antiferromagnetically coupled [Fe(3nm)/Si(1.1nm)]x15 multilayers have been deposited in UHF by magnetron sputtering at RT onto oxidized Si wafers. The crystalline structure of our samples and their multilayer periodicity were examined using the high- and small-angle X-ray diffraction, respectively [1]. The observed high magnetoresistance effect at zero external magnetic fields, up to 90%, is very interesting from the viewpoint of technological applications. Both the low- and high-resistance states exhibit a non-linear variation, whose I-V curves are very well fitted by Brinkman-Dynes-Rowell model theory [2]. These features are characteristic for tunnel junctions with asymmetric barriers and indicate different conditions at the diffused Fe/Si and Si/Fe interfaces.

Based on our experimental results, we can interpret the current-induced resistive switching at a nanocontact Au-tip – Fe/Si multilayer as follows.
We assume that observed CIRS has rather the ballistic magneto-resistance (BMR) effect like to this proposed by Jiang [3]. This BMR effect arises from nonadiabatic spin scattering across very narrow (atomic scale) magnetic domain walls trapped at nano-sized constrictions, which is nano-pinhole created in insulator Si-sublayer separated two Fe-sublayers. The nature of the CIRS, however, is not clearly known at this moment. It is clear that the resistance change have a close relationship with local magnetic structure of the narrow pinhole across Si sublayer.

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