RESISTANCE CHANGES SIMILAR TO BALLISTIC MAGNETORESISTANCE IN ELECTRODEPOSITED NANOCONTACTS.

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We have studied the behavior of electrodeposited Ni and Fe nanocontacts in magnetic fields and the changes in resistivity (ΔR) that occur. Metallic particles suspended in plating solution, created and collected from the electroplating bath of a nanocontact that later exhibited high values of ΔR/R, have been successfully transferred to a second set of electrodes where similar high values of ΔR/R were measured without any plating process being performed. We attribute this effect to a mechanical reorientation of magnetic nanoparticles at the junction between the electrodes as the field is close to zero, and relate this work to present work with ballistic magnetoresistance in nanocontacts. We also show that Fe whiskers brought in close contact can produce this effect as well.

Figure 1 show a typical response from a smooth Ni contact exhibiting a ΔR/R of 0.1 %. In the 200 Ni or Fe contacts grown over a period of several months the ΔR/R varied between 0.0 % and 1.4 %. With the Fe solution and the higher plating potential the aggregate like deposits show ΔR/R values of 10 % to 80 % in most cases and occasionally values of thousands of percent. Figure 2 shows a typical curve for an aggregate like contact with a ΔR/R of 46 %, this curve could be repeated several times with only small variations in ΔR/R between runs. Sometimes larger broken off clusters within the vicinity of the contact could be seen moving around with the change in the applied field. A varnish was found to be a suitable material to restrict this motion without changing the base resistance too much. The curve in Fig. 3 is from the same aggregate like contact as in Fig. 2 but after applying a coating of varnish that was allowed to dry for 10 minutes. Figure 3 shows a ΔR/R of only 0.3 % after the application and drying of the coating. During the plating process of aggregate like contacts it was possible to use a pipette and extract small amounts of plating solution from the vicinity of the growth region, in which metal particles were suspended. When this solution was placed in the gap of a new unused pair of electrodes with a spacing of ≈50 µm curves such as the one in Fig. 2 with a ΔR/R of 19 % could repeatedly be generated.

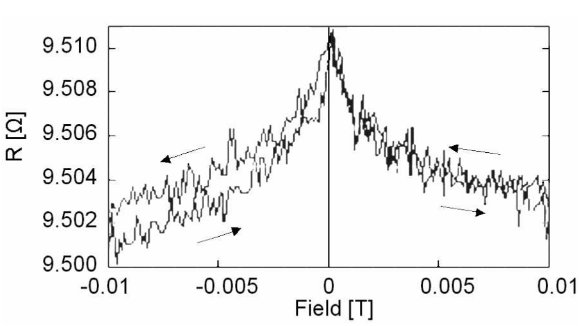

Fig. 1 Magnetic field vs. resistivity measurement for a nanocontact formed from a continuous Ni plated film. The field was applied from +0.100 T to –0.100 T, and then in the reversed direction. The change in resistivity is ≈0.1 %.

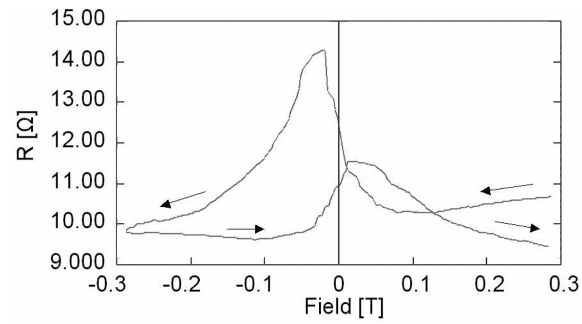

Fig. 2 Magnetic field vs. resistivity measurement for a Fe plated aggregate like nanocontact. The field was applied from +0.300 T to –0.300 T, and then in the reversed direction. The change in resistivity is ≈46 %.

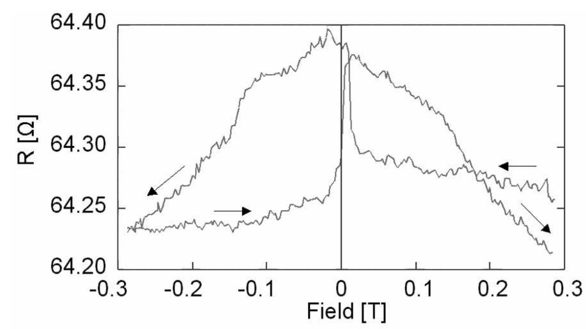

Fig. 3 Magnetic field vs. resistivity measurement for the Fe plated aggregate like nanocontact, now embedded in a rigid polymer. The field was applied from +0.300 T to –0.300 T, and then in the reversed direction. The change in resistivity is less than 0.3 %.