Summary

In this work we studied with monte carlo simulations critical phenomena in granular ferromagnets embedded in an insulating substrate and constructed in a critical density of nanomagnetic grains. These kind of materials have characteristic magnetoresistance curves with many unique fluctuations.

Magnetic nanoparticles that evaporated in an insulating matrix form islands. As the number of nanoparticles increases, islands begin to form that coalesce to larger clusters. The conductivity in such systems is determined in the terms of percolation theory. According to the percolation theory conductivity exists only when the concentration of nanomagnetic grain is higher than a critical density p_c. The width of the materials whose density of islands is above the critical point p_c is called *critical width.* Granular ferromagnets which formed near the critical width have these characteristic fluctuations in the magnterosistance curves. In order to explain these fluctuations, it is assumed that the total conductivity depends from some bottleneck grains, which acts as red bonds. A *red bond* is a bond of the system through which almost all the electrical current flows. Some pairs of grains may have the same properties as the red bonds. So the fluctuations are caused by the flip of the magnetic moment of the bottleneck grains.

In order to test this hypothesis, we have performed large scale computer simulations. We constructed a Miller-Abrahams two-dimensional *Random Resistor Network* which has been previously used for the modeling of magnetic materials. The sites of the network are assumed to be nanomagnetic grains with two possible dimensions of their magnetic moments (up and down) and the local conductivities are assumed to be the contacts between neighboring pairs of grains. This way we have constructed a realistic model of the surface of the granular ferromagnetic material. The magnetoresistance curves are in good agreement with the experimental results. We also studied the impact of the red bonds in total conductivity. By measuring the quantity R_{cut}/R (where R is the total resistance and R_{cut} is the total resistance after removing a red bond) we confirm that it scales as $\kappa^{4/3}/L$ and $\kappa/L^{1/1.3}$, where κ is the measure of the disorder of the system (κ is inversely proportional to the density of grains) and L is the system size.