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The metric influence on magnetic and electrical transport properties of nanoparticles

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Abstract – In this work, different metrics have been used in order to change the shape on nanoparticles. After that, magnetic and electrical transport properties as magnetization, susceptibility and resistivity of generic nanoparticles have been simulated by using Monte Carlo and Heisenberg model. Nanoparticles are considered composed by magnetic ions with spin magnitude 1. The Hamiltonian considers different terms line interaction between nearest neighbors, surface and bulk anisotropy and external magnetic field influence. Results show an increase of critical temperature as a function of surface and volume ions ratio. This parameter, with strongly depends on the metric employed has also high influence on magnetization, and coercive force.

Nanomaterials are experiencing a rapid development in recent years due to their existing and/or potential applications in a wide variety of technological areas such as electronics, catalysis, ceramics, magnetic data storage, structural components etc. To meet the technological demands in these areas, the size of the materials must be reduced to nanometer scale. Moreover, thermodynamic properties are also influenced by the geometry of the nanoparticles, which in turn depends on the specific route of chemical or physical synthesis giving rise for instance, in some cases, to nanoparticles with a closer spherical shape or in some others nanoparticles exhibiting faces like polyhedral [1]. Although nanoparticles with a close spherical shape have been studied and experimentally obtained, other shapes have not been extensively studied even though they can be potentially important for nanoelectronic devices and catalysis applications [2]. For building the nanoparticles, the metric given by

$$d_{Lp}(\vec{x},\vec{y}) = \left(\sum_{i=1}^{n} |x_i - y_i|^p \right)^{1/p} \qquad (1)$$

was used, being x_i and y_i any nanoparticle points and p is a possitive number. As p increases, the shape of nanoparticle tends to cubic, as is shown in fig. 1. Fig. 2 shows the metric influence on the critical temperature. As it was spected, T_c increases and finaly it reaches the saturation after p is greater than 2 (spheric). For $p=10$, the cubic shape is produced. Critical temperrature is also afected by the surface- volume ions ratio. It is due the ions on the surface have lower bonds that those placed into the nanoparticle volume.

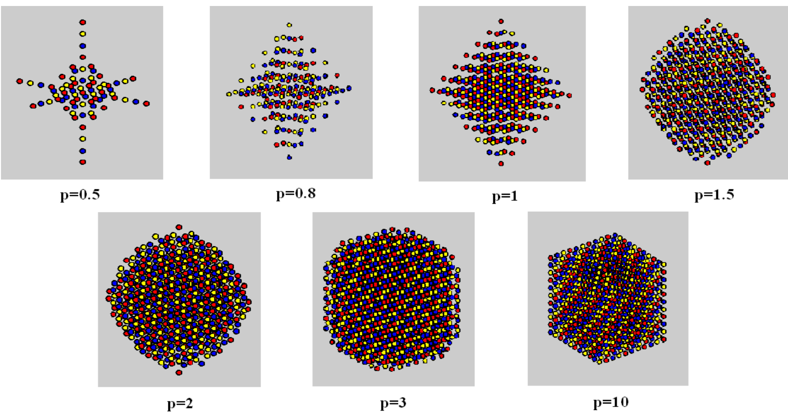

Figure 1: Different shapes of nanoparticles for several values of *p*

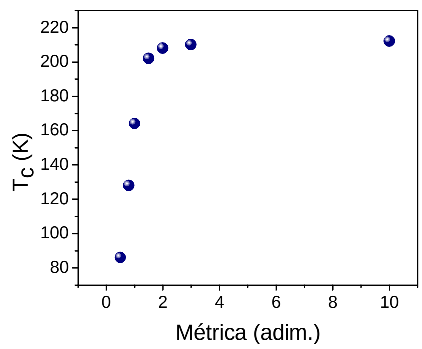

Figure 2: Critical temperature T_c as a function of the metric *p*

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