Magnetic fields interactions phenomena in guidance and focusing of magnetic micro and nanoparticles

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Fabrication of magnetic particles (MPs), either at micro or nano scale, it has been widely studied as well as some of their applications like cancer treatment, degenerative diseases diagnostic, contrast agents, etc.; but since Nanotechnology represents a new frontier between biology, chemistry and physics it is necessary do not leave out any phenomena like movement of MPs in viscous fluids under the action of static magnetic fields. All before could be important understand it to be able to control movement of the MPs [1], [2] and [3].

In this research, we present phenomena that involve movement of MPs. It must be note that movement can refer to guidance and focusing, and they are not the same. The first one represents the capacity to move MPs into a predefined path, the second one tries to agglomerate the biggest amount of MPs in a specific location. Both of them are under the influence of external magnetic field and immersed in a viscous medium. The identification of interaction phenomena can lead us to make an important differentiation of particles that could be used for biomedical applications.

Because the phenomena founded come from guidance and focussing of micro and nanoparticles experimentation, it is important to highlight that we had developed a methodology to obtain average velocity and their path into an essay tube filled of a medium whose viscosity is a little bit higher than water's, with which we make a comparative analysis [4]. Results have been successfully done, but this work is aimed at discussing two phenomena that appear in our methodology: 1) self-organization of MPs in presence of magnetostatic field, even if it is low (see Figure 1); and 2) agglomeration of MPs (see Figure 2). These phenomena are neither published nor explained until now.

Apparently, waiting for a better set of experiments to achieve better statistical results, it has been identified that self-organization experienced by MPs is memoryless; this is, even if MPs are introduced into the essay tube in random way, the phenomenon appears and has the same behavior. Therefore, it could be supposed repeatability. On the other hand, agglomeration phenomenon shows that MPs can keep their agglomeration position even without magnetostatic field influence. Both phenomena, well characterized, can lead to better control of MPs behavior for biomedical applications, which is our goal.

Future work is in the way to obtain better mathematical approximation of phenomena explained before, and to extend number of experiments to make sure implications of both of them and to offer a better statistical results as well as image background.

References:

[1] Correia A, **Nanociencia y Nanotecnología En España.** Fundación Phantoms, 2008, pp. 239.

[2] Alexiou C, Diehl D, Henninger P, Iro H, Rockelein R, Schmidt W and Weber H, *IEEE Trans. Appl. Supercond.*, **A high field gradient magnet for magnetic drug targeting**, vol. 16, 2006, pp. 1527-1530 (ISSN: 1051-8223).

[3] Gleich B, Hellwig N, Bridell H, Jurgons R, Seliger C, Alexiou C, Wolf B, Weyh T, *IEEE Transactions on Nanotechnology,* **Design and evaluation of magnetic fields for nanoparticle drug targeting in cancer**, vol. 6, 2007, pp. 164-170 (ISSN: 1536-125X).

[4] R.A. García Mendoza, A. Macías Delgado, J.J. Serrano Olmedo, F. del Pozo Guerrero, *Libro de Resúmenes Congreso Anual de la Sociedad Española de Ingeniería Biomédica,* **Primeras Experiencias en Guiado y Focalización de Micro y Nanopartículas Magnéticas con fines Biomédicos**, 2009, p. 167 (versión completa en CD de Congreso).

Figures:

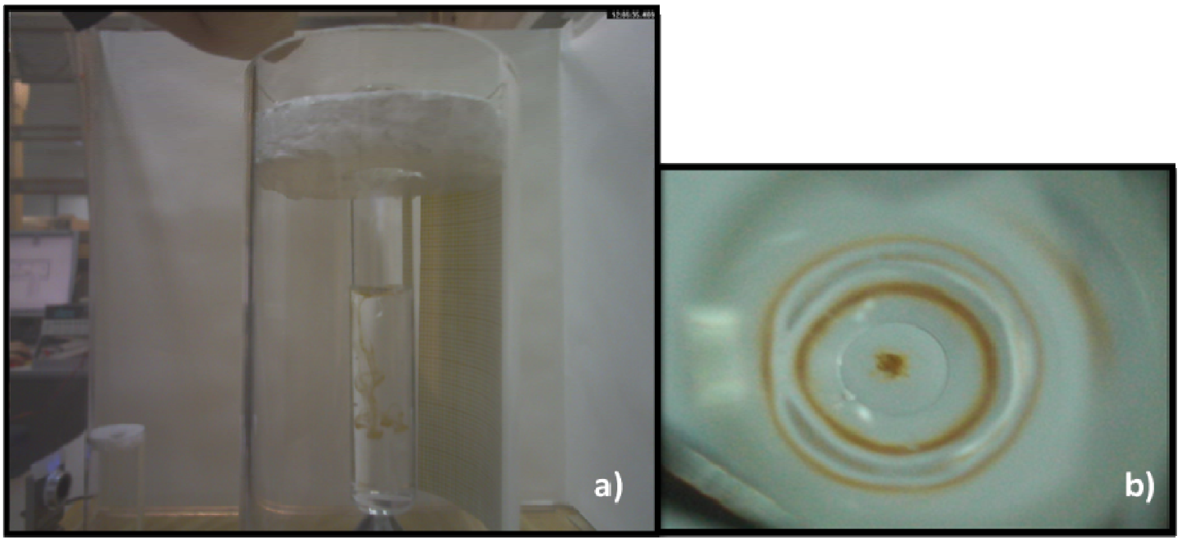

Figure 1.Phenamenon of self-organization under magnetostatic field using magnet plus cone and 1,31 µm diameter MPs: in a) lateral view, and b) view from top of essay tube.

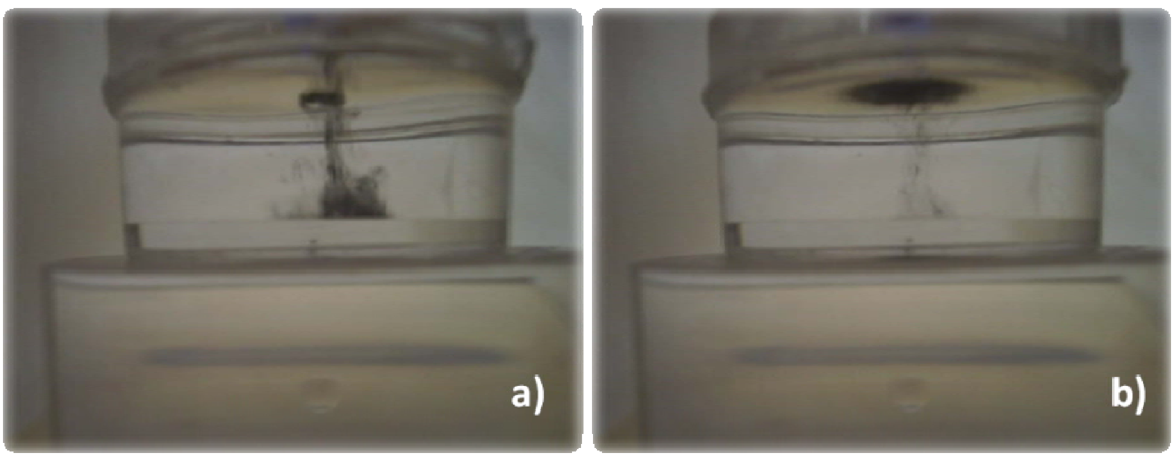

Figure 2.Phenamenon of agglomeration under magnetostatic field using magnet plus cone and 8 µm diameter MPs: in a) response of MPs to magnetostatic field, and b) agglomeration of MPs.