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Numerical modelling of oocytes partially covered by magnetic nanoparticles in external magnetic fields

Gregorio J. Molina-Cuberos[1], Ángel J. García-Collado[2], Francisco A. García Vázquez[3], María Jiménez Movilla[4]

[1] *Dpto. Electromagnetismo y Electrónica, Facultad de Química, Universidad de Murcia.*

[2] *Dpto. Ciencias Politécnicas. Grupo de Investigación en Telecomunicaciones Aplicadas (GRITA), Universidad Católica de Murcia, Murcia.*

[3] *Dpto. Fisiología, Facultad de Veterinaria, Universidad de Murcia*

[4] *Dpto. Biología Celular e Histología, Facultad de Medicina, Universidad de Murcia*

Nanorep® is a novel device based on the magnetic tweezer concept that has been developed for precise, fast, and non-aggressive oocytes and embryos manipulation. To operate the reproductive cells, they are first immersed in a standard host medium with ferrite containing nanoparticles. The magnetic particles are attached to the external matrix of the oocytes/embryos thanks to a linked protein making possible to control them by using external magnetic fields. Electron microscope photographs show magnetic particle aggregates around the oocyte. The total mass and distribution of the attached magnetic particles per oocyte show a wide range of variability, which strongly affects their magnetic response. Despite the uncertainties on the attachment of magnetic nanoparticles, the set formed by the oocyte and the nanoparticles can be caught and transported by using standard neodymium magnets.

Here we present an initial study of the interaction between the set oocyte/nanoparticles and the external magnetic field in aqueous environment. We are going to discuss several relevant topics of the model such us the characterization of magnetic field produced by cylindrical neodymium magnets, the model of the ferrite magnetization as an effective spherical dipole or a magnetized spherical shell, the measurement processes to obtain the temporal evolution of the particle position and the different observed dynamic behaviours.

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