CARBON COATED MAGNETIC NANOPARTICLES FOR TARGETED DRUG DELIVERY USING MAGNETIC IMPLANTS

M.R. Ibarra[1, 2], R. Fernández-Pacheco[1], C. Marquina[2], J.G. Valdivia[1, 3], M. Gutiérrez[1, 3]
[1] Instituto Universitario de Investigación en Nanociencia de Aragón (INA), Universidad de Zaragoza, Edif. Inter. II, Pedro Cerbuna 12 50009 Zaragoza Spain.
[2] Instituto de Ciencia de Materiales de Aragón (ICMA), CSIC, Facultad de Ciencias- Universidad de Zaragoza, Pedro Cerbuna 12, Zaragoza, 50009, Spain
.[3] Hospital Clínico Universitario "Lozano Blesa", Avda Gomez Laguna, 50009 Zaragoza Spain
ibarra@unizar.es

Bioferrofluids obtained from carbon coated iron nanoparticles are promising candidates for targeted drug delivery. The carbon coating assures biocompatibility of the particles, and provide a good support for drug adsorption. In the present case, the arc discharge (Krätschmer-Huffman [1]) method has been used in order to get the carbon coating. A combination of magnetic and carbon nanostructures has been obtained: magnetic nanoparticles encapsulated in carbon nanotubes, and particles encapsulated either in graphitic or amorphous carbon cages. The morphological and structural characterisation (by means of TEM, XRD and dynamic light scattering), as well as the study of the magnetic properties (by means of magnetisation and Mössbauer spectroscopy) of the obtained products has been carried out. A combined chemical and magnetic method has been used for separating the magnetic carbon encapsulated particles, prior the production of the biocompatible fluid [2].

Preliminary haematological studies have been performed in New Zealand rabbits as well as in *in-vitro* human blood. These tests suggest that the injection of our magnetic bioferrofluid does not modify blood and plasma viscosity and that erythrocyte aggregation remains within normal limits, with very small variations without clinical significance. In order to be used as drug magnetic carriers for cancer chemotherapy, doxorrubicin has been adsorbed on the carbon nanoparticles surface. The kinetics of drug adsorption-desorption of doxorubicin has also been studied.

Our method to target the chemotherapeutic magnetic carriers to the tumoral cells consists of gold plated permanent magnets implanted directly in the affected organ, by laparoscopic technique [3]. The bioferrofluid charged with the chemotherapeutic agent is injected intravenously and the particles are progressively attracted to the magnet. Therefore, the drug desorption takes place at the tumour region. This method seems to be more promising, costless and effective than those based on the application of external magnetic fields. It allows the treatment of tumours localized in deep organs, because of the large field gradient achieved in the neighbourhood of the magnet. This gradient is about 5 kOe/cm, and can not easily be reached by external applied magnetic fields. A pre-clinical experimental animal model is described.

References:

[1] Kratschmer W., Lamb L.D., Fostiropoulos K. and Huffman D.R. *Nature* **347** (1990) 354.
[2] J.M. De Teresa, C. Marquina, D. Serrate, R. Fernandez-Pacheco, L. Morellon, P.A. Algarabel, M.R. Ibarra, Int. J. Nanotechnology **2** (2005) 3.
[3] R. Fernández-Pacheco, M.R. Ibarra, J.G. Valdivia, C. Marquina, D. Serrate, M.S. Romero, M. Gutiérrez, J. Arbiol, Technical Proceedings of the 2005 NSTI Nanotechnology Conference and Trade Show, ISBN 0-9767985-0-6