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Synthesis of hybrid, carbon-based magnetic, hybrid nanoparticle systems using dense-medium, atmospheric pressure plasma approaches

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Magnetic nanoparticles embedded in non-magnetic host materials, including carbon structures are of special interest due to the fact that embedding provides encapsulation and prevents grain grow and agglomeration. A combination of magnetic and electrical properties and the accessibility to chemical modification of particles open up significant ways for biotech applications. It has been suggested that the size of the immunizing antigen particles controls their interaction with specific Antigen Presenting Cells (APCs). Bacterial sized (> 1μm) uptake is favored by macrophages, while viral-sized (< 100 nm) are preferentially engulfed by DCs. Using an original Dense Medium Plasma (DMP) technologies and plasma reactors provided with iron electrodes, C and C/N based uniformly sized (40-80nm) hybrid iron and iron oxide containing magnetic nanoparticles (CMNP) were synthesized by starting from benzene and acetonitrile. Based on ESCA results, Fourier transform IR spectroscopy, Raman spectroscopy, AFM and SEM it was shown that the nanoparticles are composed of graphitic carbon or graphitic carbon containing nitrogen atoms and small amounts of iron and iron oxide. Thermal gravimetry/differential thermal gravimetry analysis indicates that these particles are stable up to temperatures as high as 600 oC. Ferromagnetic resonance spectroscopy (FMR) and extended x-ray absorption fine structure spectroscopy suggest that most of host structures is related to metallic Fe. Magnetite and maghemite is also present in the structure of the metallic particles. It was also demonstrated that part of the nitrogen atoms included into the acetonitrile-based structures are in the form of primary amine functionalities. In this presentation based on "*in vitro*" and "*in vivo*" experimental data, the potential use of functionalized plasma-synthesized nanoparticles in future immunotherapy applications is also discussed.

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