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Bone tissue engineering guided by magnetic forces and magnetic scaffolds

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A major challenge is of bone tissue engineering is to regenerate bone tissue with a controlled three dimensional architecture able to reproduce the native biological and mechanical characteristics. The application of magnetic forces to orient, *in vitro*, the osteoblasts and the collagen fibrils according to magnetic field lines and to boost cell proliferation and differentiation has been yet demonstrated. The objective of the present study is to show that magnetic forces can guide bone tissue regeneration in a well-defined three dimensional pattern according to the applied magnetic field. 24 hydroxyapatite/collagen (70:30) scaffolds magnetized with magnetic nanoparticles according to two different magnetization methods, were implanted in both the lateral femoral condyles of 12 rabbits in contact with a permanent magnet. Nonmagnetic scaffolds were also implanted as control group. Magnetized scaffolds showed new bone tissue formation at both follow-up times (4-12 weeks) and no adverse reactions occurred. For the first time *in vivo*, it is also revealed that, in the presence of static magnetic field, the scaffold collagen fibrils oriented parallel to the magnetic field after 4 weeks, whereas after 12 weeks the new bone formation is oriented perpendicular to the magnetic lines compared with the random tissue regeneration showed by the control group. Nanomechanical tests have been also carried out in order to address the new bone tissue maturity at 4/12 weeks. These findings open the way to the fascinating possibility of recreating *in vivo* the three dimensional functional architecture of bone tissue guided by magnetic forces and magnetic scaffolds.

Biography

Alessandro Russo got his Master Degree in Medicine and Surgery in 2000 and PhD in 2009 at University of Bologna. Since 2001, he has been carrying on numerous research regarding knee prosthesis fixation and polyethylene wear by means of Roentgen Stereophotogrammetric Analysis (RSA) technique. The main field of interest is the application of nanostructured materials in orthopaedic surgery. Presently, he is orthopaedic Surgeon and Researcher at the Laboratory of NanoBiotechnologies of the Rizzoli Orthopaedic Institute, Italy.

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A transport model for thermodynamic estimation of cryogenic hydrogen

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Hydrogen is a foundation element of the universe and has attracted attention as a key of the solution for the energy and environmental problem. However, liquid hydrogen shows strange behavior as compared to other field due to the nuclear quantum effect. Because of this effect it is difficult to comprehend the thermodynamic and transport properties of liquid hydrogen by using the usual method. Therefore several methods have been proposed to reproduce the time evolution of the molecules in which the nuclear quantum effect contributes to their behavior. However, since the previous studies are still verification stage of the methods, an effect of the nuclear quantum nature of hydrogen and its mechanism on the thermodynamics and transport properties have not been clarified in details. Especially, how the quantum nature would effect on the energy transfer in molecular scale has not been clarified. In this study, therefore, we investigated the effect of this quantum nature and its mechanism on the thermodynamics and transport properties of cryogenic hydrogen using classical molecular dynamics (MD) methods. We applied Centroid Molecular Dynamics (CMD) methods, Ring Polymer Molecular Dynamics (RPMD) methods, and Maximum Entropy numerical analytic continuation (MEAC) methods. First, we have conducted thermodynamics estimation of cryogenic hydrogen using the MD methods. As a result, it was confirmed, that both quantitative and qualitative effect of the quantum.

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