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Nanoparticle modified bioactive polymeric and metallic implants

We address a detailed biomedical research using different nanomaterials on implant material surfaces that feature strong bioactive properties covering both permanent and biodegradable implant applications. These materials act as local antibacterial and cell-proliferative platforms towards ideal implants with combined properties. These nano-objects are based on ultrapure gold, platinum, silver or iron nanoparticles, equipped with biological functions for specific cellular actions via full-embedding into polymeric matrices or used as coatings on metallic implants. Instead of standard fabrication, we demonstrate short-pulsed laser ablation in liquids that is an entirely precursor-, and stabilizer-free green method, forming contamination-free nanomaterials with remarkable surface loadings in a single-step process. Industrial processing of nanoparticle-embedded polymers by injection molding results in a homogenous embedding whereas the nanoparticles stay stable even in the melted state due to an effective stabilization process during laser ablation that hinders inter-particular agglomeration. This very high homogeneity and stability is especially crucial for catheterization and permanent cardiovascular applications where homogenous surface activity is required. Concerning metallic implant applications, equal channel angular pressing (ECAP)-modified low-alloyed magnesium, as well as pure titanium and titanium alloys will be presented covering a broad range in medical implantology from endosseous-, cochlear-, to artificial heart implants. In case of magnesium, the desired combination of high biocompatibility, tailored mechanical and degradation properties as well as excellent mechanical properties will be presented and compared to state-of-the-art materials such as the extra-low interstitial Ti 6Al-4V titanium alloy or the unalloyed commercially pure titanium. A modified ECAP procedure reveals formation of an ultrafine grain structure across the whole work piece that allows homogeneous mechanical properties affecting positively its cellular activity. Finally, we report on the detailed mechanical and corrosive properties providing deep insights into its biophysical performance, long durability and mechanical strength even in a biological environment.

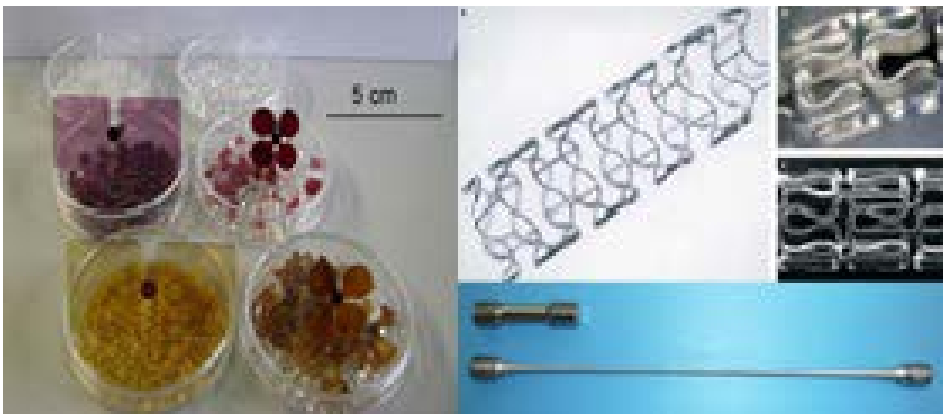

Figure 1: Laser-generated bioactive polymeric nanocomposites with embedded gold and silver nanoparticles on TPU-basis (left) titanium alloy and biodegradable magnesium with high tensile-strength and ductility (right).

Recent publications

1. A Polyak, L Sajti et al. (2017) Preparation and 68Ga-radiolabeling of porous zirconia nanoparticle platform for PET/CT-imaging guided drug delivery operations, J. Pharm. Biomed. Anal. 137:146-150.
2. J Draxler, et al. (2017) The potential of isotopically enriched magnesium to study bone implant degradation *in vivo*, Acta Biomaterialia, 51:526-536.
3. A Barchanski, D Funk, O Wittich, C Tegenkamp, B N Chichkov and L Sajti (2015) Picosecond laser fabrication of functional gold-antibody nanoconjugates for biomedical applications, J. Phys. Chem. C. 119(17):9524–9533.
4. J Hofstetter, et al. (2015) Assessing the degradation performance of ultrahigh-purity magnesium *in vitro* and *in vivo*, Corrosion Science, 91:29-36.
5. C Hess, A Schwenke, L Sajti, et al. (2014) Dose-dependent surface endothelialization and biocompatibility of polyurethane noble metal nanocomposites. J. Biomed. Mater. Res. A 102(6)1909-1920.

Biography

L Sajti graduated as a Physicist in 2004 from the University of Szeged in Hungary and received his PhD in 2007 in Material Sciences from the University of Marseille in France. He was a Post-Doctoral Fellow in 2008-2009 with the excellence initiative of the Australian Government in the Australian National University in Canberra. Later, he worked in Laser Zentrum Hannover e.V. in Germany in 2009-2011 as a Scientific Employee then from 2011 to 2017 as Head of the research group Nanomaterials. Additionally, during 2011-2017 he headed the research unit Nanoparticles in the German cluster of excellence REBIRTH - from Regenerative Medicine to Reconstructive Therapy in the Hannover Medical School. During 2015-2017 he was responsible of the research module "Laser-based methods - switchable implant coatings with drug-releasing nanoparticles" within the interdisciplinary research cluster Biofabrication for NIFE in Germany. At present, he is Head of the research group Advanced Implant Solutions at the AIT Austrian Institute of Technology GmbH.

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