conferenceseries.com

1550th Conference

3rd Annual Conference and Expo on

BIOMATERIALS

March 05-06, 2018 | Berlin, Germany

Keynote Forum

Day 1

Regine Willumeit Römer, J Biotechnol Biomater 2018, Volume 8
DOI: 10.4172/2155-952X-C1-087

3rd Annual Conference and Expo on

BIOMATERIALS

March 05-06, 2018 | Berlin, Germany

Regine Willumeit Römer

Helmholtz Zentrum Geesthacht, Germany

Degradable metallic implants - assessment of the current situation

Aging populations and a rise in osteoporosis-related fractures will sustain a need for orthopaedic intervention. In addition, juvenile patients and active adults exhibiting risky sporting activities also require perfect care. So far, these indications are treated mainly with non-degradable metal implants or in some cases also polymers. From the patient's point of view, degradable implants would clearly be preferred. Here degradable magnesium-based implants could become an alternative to permanent metallic implants which have to be removed after healing, or to replace degradable polymers which do not always show the required mechanical properties. Mg and its alloys degrade under physiological conditions. The great challenge here is to tailor the degradation in a manner that is suitable for a biological environment. Fast or uncontrolled corrosion is associated with strong hydrogen and ion release and severe pH changes, which can lead to a fast loss of mechanical stability and undesirable biological reactions. Since these processes are highly complex in a living system and sufficient data describing the degradation *in vivo* is missing, it is very difficult to produce knowledge based new alloys. Therefore, the development of new biodegradable Mg-based implants is strongly relying on the understanding of the degradation process in the living organism and the creation of an appropriate test system *in vitro*. Still, the endeavor is successful: one CE certified Mg-alloy compression screw (Magnezix, Syntellix AG, Germany) and a Mg-based drug-eluting stent (Magmaris, Biotronik AG, Germany) are in the market. In addition, in China and Korea patient trials (hip surgery and hand fracture) are reported. This presentation will outline the current status of Mg-implants and which perspectives Mg based implants could have.

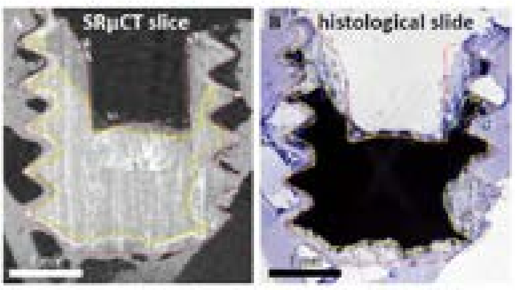


Figure 1: How much of the implant is left? Comparison between synchrotron radiation (SR) μCT (spatial resolution 2 μm) and histology shows the difficulty to quantify the actual remnants of the screw. This is even more true for patient images [image taken from [5]]. Red line: contours of the degradation layers. Yellow line: contours of the residual metallic alloy.

Recent publications

1. L Wu, F Feyerabend A F Schilling, R Willumeit Römer, B J C Luthringer (2015) Effects of extracellular magnesium extract on the proliferation and differentiation of human osteoblasts and osteoclasts in coculture. Acta Biomat. 27:294-304.
2. B J C (2016) Luthringer, R Willumeit Römer (2016) Effect of magnesium degradation products on mesenchymal stem cell fate and osteoblastogenesis. Gene 575(1): 9-20.

3. K Jähn, H Saito, H Taipaleenmäki, A Gasser, N Hort et al. (2016) Intramedullary Mg2Ag nails augment callus formation during fracture healing in mice. Acta Biomater. 36:350-360.
4. Ahmad Agha, Nezha R, Willumeit Römer, Daniel Laipple, Berengere Luthringer, Frank Feyerabend et al. (2016) The degradation interface of magnesium-based alloys in direct contact with human primary osteoblasts cells. PLoS One. 11(6):e0157874.
5. S Galli, J U Hammel, J Herzen, T Damm, R Jimbo et al. (2016) Evaluation of the degradation behavior of resorbable metal implants for *in vivo* osteosynthesis by synchrotron radiation-based x-ray tomography and histology. Proc. SPIE 9967, Developments in X-Ray Tomography X, 996704 doi:10.1117/12.2237563.

Biography

Regine Willumeit Römer started as a Physicist studying structure and function of the ribosome. After her habilitation in biochemistry she worked on membrane active antimicrobial peptides and implant coatings (for permanent Titanium-based implants). In parallel she started working on biodegradable magnesium-based implant materials. In her division Metallic Biomaterials (Institute for Materials Research, Helmholtz-Center Geesthacht) the full value chain is covered: from fundamental materials design and production via different processing routes (cast and powder metallurgy), the study of degradation mechanisms towards the biological assessment of the material in cell culture and animal models.

regine.willumeit@hzg.de

Notes:

Yongmei Zheng, J Biotechnol Biomater 2018, Volume 8
DOI: 10.4172/2155-952X-C1-087

3rd Annual Conference and Expo on

Biomaterials

March 05-06, 2018 | Berlin, Germany

Yongmei Zheng

Beihang University, China

Bioinspired surfaces with gradient micro- and nanostructures and dynamic wettability

Biological surfaces create the enigmatical reality to be contributed to learning of human beings. They run cooperate between of endlessly arranged various-style gradient micro- and nanostructures (MN) that greatly provide with excellent functions via natural evolvement. Such biological surfaces with multi-gradient micro- and nanostructures display unique wetting functions in nature for water collection and water repellency, which have inspired researchers to design originality of materials for promising future. In nature, a combination of multiple gradients in a periodic spindle-knot structure take on surface of spider silk after wet-rebuilding process in mist. This structure drives tiny water droplets directionally toward the spindle-knots for highly efficient water collection. Inspired by the roles of gradient MNs in the water collecting ability of spider silk, a series of functional fibers with unique wettability has been designed by various improved techniques such as dip-coating, fluid-coating, tilt-angle coating, electrospun and self-assembly, to combine the Rayleigh instability theory. The geometrically-engineered thin fibers display a strong water capturing ability than previously thought. The bead-on-string heterostructured fibers are capable of intelligently responding to environmental changes in humidity. Also, a long-range gradient-step spindle-knotted fiber can be driven droplet directionally in a long range. An electrospun fiber at micro-level can be fabricated by the self-assembly wet-rebuilt process, thus the fiber displays strong hanging-droplet ability. The temperature or photo or roughness-responsive fibers can achieve a controlling on droplet driving in directions, which contribute to water collection in efficiency. Besides, inspired by gradient effects on butterfly wing and lotus leaves, the surfaces with ratchet MN, flexible lotus-like MN are fabricated successfully by improved methods, which demonstrate that the gradient MN effect rises up distinctly anti-icing, ice-phobic and de-ice abilities. These multifunctional materials can be designed and fabricated for promising applications such as water-collecting, anti-icing, anti-frosting, or anti-fogging properties for practical applications in aerospace, industry and so on.

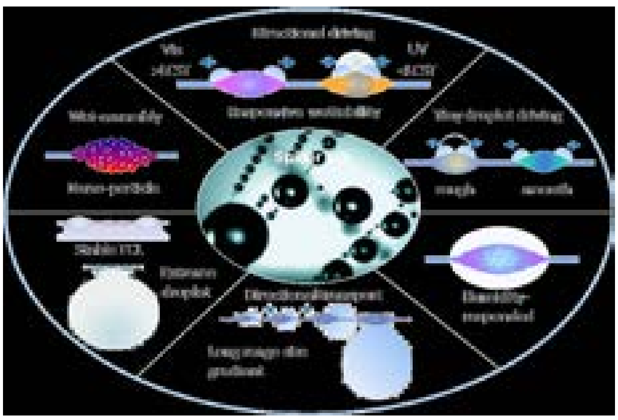


Figure 1: Illustrates the bioinspired wettability surfaces with micro- and nanostructures to control the wettability.

Recent publications

1. Zheng Y et al. (2010) Directional water collection on wetted spider silks. Nature. 463:640-643.
2. Zheng Y (2015) Bioinspired wettability surfaces: development in micro- and nanostructures. Pan Stanford Publishing. ISBN 9789814463607. 0-216.
3. Xu T, Lin Y, Zhang M, Shi W, Zheng Y (2016) High-efficiency fog collector: water unidirectional transport on heterogeneous rough conical wires. ACS Nano. 10(12):10681-10688.
4. Wang L, Gong Q, Zhan S, Jiang L, Zheng Y (2016) Robust anti-icing performance of flexible superhydrophobic surface. Adv. Mater. 28(35):7729-7735.
5. Zhang M, Wang L, Hou Y, Feng S, Zheng Y (2015) Controlled smart anisotropy unidirectional spreading of droplet on fibrous surface. Adv. Mater. 27(34):5057-5062.

Biography

Yongmei Zheng, PhD, is a Professor at School of Chemistry, Beihang University. Her research interests are focused on bioinspired surfaces with gradient micro- and nanostructures to control dynamic wettability, and develop the surfaces with characteristics of water repellency, anti-icing, anti-frosting, or fog-harvesting, tiny droplet transport, water collection, fog-harvesting and so on. Her publications include more than 90 SCI papers included in *Nature, Adv. Mater., Angew. Chem. Int. Ed., ACS Nano, Adv. Funct. Mater*., etc., with 12 cover stories, and a book "*Bioinspired Wettability Surfaces: Development in Micro- and Nanostructures*" by Pan Standard Publishing, USA. Her work was highlighted as Scientist on News of Royal Society of Chemistry, Chemistry World in 2014. She is a Member of Chinese Composite Materials Society (CSCM), Member of Chinese Chemistry Society (CCS), American Chemistry Society (ACS), International Society of Bionic Engineering (ISBE), and International Association of Advanced Materials (IAAM). She won an ISBE outstanding contribution award in 2016 by ISBE and an IAAM Medal in 2016 by IAAM, in Sweden.

zhengym@buaa.edu.cn

Notes:

Dmitry Volodkin, J Biotechnol Biomater 2018, Volume 8
DOI: 10.4172/2155-952X-C1-087

3rd Annual Conference and Expo on

BIOMATERIALS

March 05-06, 2018 | Berlin, Germany

Dmitry Volodkin

Nottingham Trent University, UK

Planar and curved self-assembled polymer multilayers - novel approaches for biomolecule immobilization and release on demand

Polymer-based and composite multilayers have been widely used over the past decade towards biological and non-biological applications. Our research is focused on assembly of 2D and 3D multilayer structures (planar films and capsules) aiming at biological applications. Such tailor-made structures have fine-tuned architecture, controlled thickness from nano to micro, adjusted softness from Pa to GPa, and almost unlimited variety of functional compounds. In this talk I present our recent findings in the mechanism of multilayer assembly, physical-chemical approaches to immobilize biomolecules (proteins, nucleic acids, small drugs, etc) and to release/deliver the biomolecules in controlled manner. The externally triggered release on demand by IR-laser light and cellular studies including extra- and intra-cellular delivery is considered. The developed structures offering localized, remote, and non-invasive release of biomolecules are indispensable for applications in diagnostics, toxicology, tissue engineering, and especially for single cell studies where high precision of biomolecule delivery in space and time is highly desirable.

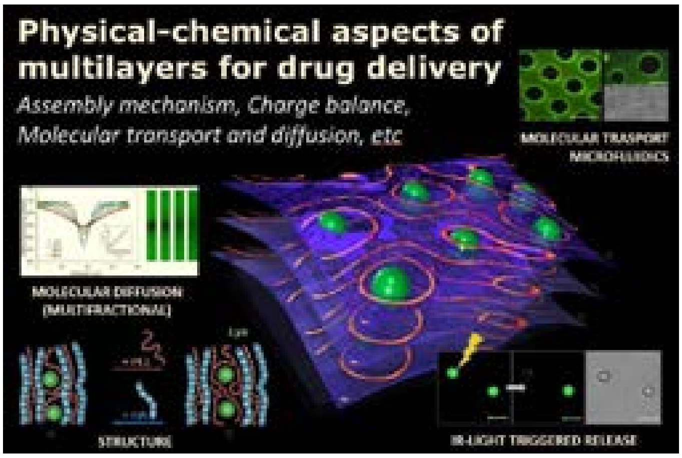


Figure 1: Schematics showing main physical-chemical aspects studied for polymer multilayers aiming at drug delivery applications

Notes:

Recent publications

1. Vikulina A S, Aleed S T, Paulraj T, Vladimirov Y A, Duschl C, von Klitzing R and Volodkin D (2015) Temperature-induced molecular transport through polymer multilayers coated with PNIPAM microgels. PCCP 17:12771-12777.
2. Vikulina A S, Anissimov Y G, Singh P, Prokopovic V Z, Uhlig K, Jaeger M S, von Klitzing R, Duschl C and Volodkin D (2016) Temperature effect on the build-up of exponentially growing polyelectrolyte multilayers. An exponential-to-linear transition point. PCCP 18:7866-7874.
3. Balabushevich N G, de Guerenu A V L, Feoktistova N A, Skirtach A G and Volodkin D (2016) Protein-containing multilayer capsules by templating on mesoporous CaCO3 particles: post- and pre-loading approaches. Macromol Bioscie 16:95-105.
4. Prokopovic V Z, Vikulina A S, Sustr D, Duschl C and Volodkin D V (2016) Biodegradation resistant multilayers coated with gold nanoparticles. Towards tailor-made artificial extracellular matrix. ACS Applied Materials & Interfaces 8:24345-24349.
5. Parakhonskiy B V, Yashchenok A M, Möhwald H, Volodkin D and Skirtach A G (2017) Release from polyelectrolyte multilayer capsules in solution and on polymeric surfaces. Adv Mater Interfaces 4:1600273.

Biography

Dmitry Volodkin holds a position of Reader in Materials at Nottingham Trent University (UK) and Heads the group Active Bio-Coatings. He has studied Chemistry at the Lomonosov Moscow State University and further obtained PhD in 2005. Research stays brought him to University of Strasbourg, France and Max-Planck Institute of Colloids and Interfaces; Technical University of Berlin; Fraunhofer Institute for Cell Therapy and Immunology in Germany. His research activities are focused on design of advanced stimuli-responsive biomaterials for applications in tissue engineering, diagnostics, toxicology, drug delivery. His group engineer self-assembled polymer based 2D and 3D structures with tailor-made properties: multilayer films, microcapsules and beads, liposome-polymer composites, polymeric scaffolds, etc. He has published more than 70 peer-reviewed articles/books and received a number of prestigious scientific awards such as Sofja Kovalevskaja Award of Alexander von Humboldt Foundation, Richard-Zsigmondy Price of German Colloid Society, Alexander von Humboldt Fellowship and Marie Skłodowska-Curie Fellowship.

dmitry.volodkin@ntu.ac.uk

Notes:

Laszlo Sajti, J Biotechnol Biomater 2018, Volume 8
DOI: 10.4172/2155-952X-C1-087

Laszlo Sajti
Austrian Institute of Technology, Austria

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.

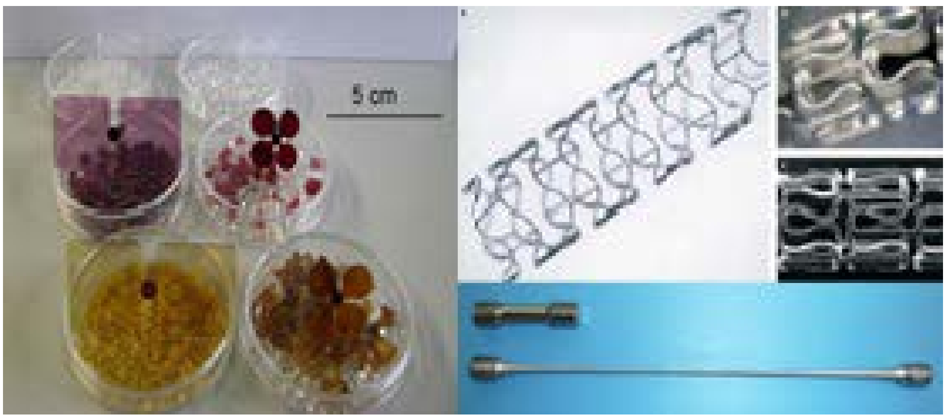


Figure 1: Laser-generated bioactive polymeric nanocomposites with embedded gold and silver nanoparticles on TPU-basis (left) titanium alloy and biodegradable magnesium with high tensile-strength and ductility (right).

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.

Laszlo.Sajti@ait.ac.at

Notes:

3rd Annual Conference and Expo on

Biomaterials

March 05-06, 2018 | Berlin, Germany

Keynote Forum

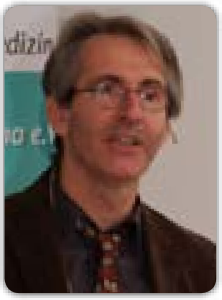
Day 2

Bernhard Mingler, J Biotechnol Biomater 2018, Volume 8
DOI: 10.4172/2155-952X-C1-087

3rd Annual Conference and Expo on

Biomaterials

March 05-06, 2018 | Berlin, Germany



Bernhard Mingler

Austrian Institute of Technology GmbH, Austria

Biomaterials with unique properties for implant applications

Equal Channel Angular Pressing (ECAP) is an innovative processing technology for the production of metallic biomaterials with unique properties. It leads to a strong grain refinement of bulk crystalline materials down to the sub-micrometer range by means of very large, multidimensional plastic deformation under enhanced hydrostatic pressure. The modified microstructure of ECAP-processed biomaterials is the reason for high strength combined with good ductility. Such high-performance biomaterials are very promising candidates for applications in high-loaded implants, for longer implant lifespans, for the miniaturization of implants and for completely new implant concepts. The effects of ECAP are presented on the examples of commercially pure (CP)-titanium and special Mg-alloys. CP-Ti is a commonly used implant material especially in dentistry. In this field of application, the Ti-alloy Ti6Al4V-ELI is avoided because of its problematic alloying elements aluminum and vanadium. Nevertheless, for many dental applications a higher strength than that of CP-Ti is requested. Using ECAP and tailored optional post-processing we achieved in CP-Ti ultimate tensile strengths >1000 MPa, which is stronger than the Ti-alloy. A further very important effect of ECAP is that it produces a very homogeneous ultrafine grain structure and consequently very homogeneous mechanical property across the whole work piece. The ideal material for biodegradable implants must combine high biocompatibility, application-oriented degradation rate and excellent mechanical properties especially for load bearing applications. To achieve all these goals, we used a newly developed double-ECAP tool to process a special low alloyed Mg alloy which was developed and produced at AIT. The double-ECAP tool consists of three channels with two intersection angles and offers exceptional high deformation efficiency. By using it, the ultimate tensile strength of a ZX00 Mg alloy could be raised to unprecedented strength values of about 400 MPa.

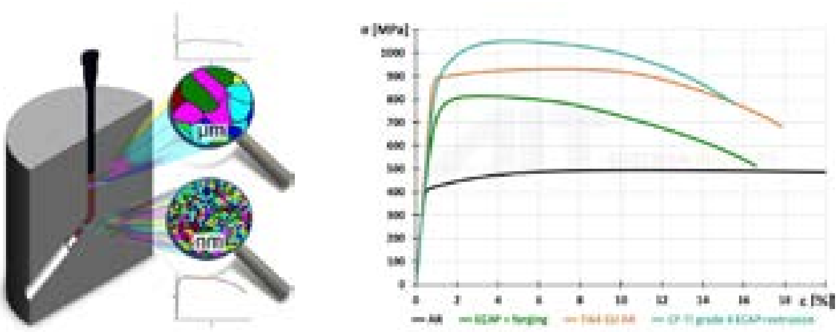


Figure 1: Principle of Equal Channel Angular Pressing ECAP (left); stress strain curves of CP-Ti in different conditions in comparison with Ti6Al4V- ELI. CP-Ti grade 4 after ECAP + extrusion is stronger than the Ti alloy

Recent publications

1. Draxler J, Martinelli E, Weinberg A, Zitek A, Irrgeher J et al. (2017) The potential of isotopically enriched magnesium to study bone implant degradation *in vivo*. Acta Biomaterialia. 51:526-536.
2. Mingler B, Krystian M, Horky J, Bammer M (2016) High-strength biomaterials for implants. Biomed Tech 2016; 61 (s4) © by Walter de Gruyter • Berlin • Boston. DOI 10.1515/bmt-2016-5000 S4.
3. Krystian M, Bryla K, Horky J, Mingler B (2017) Equal Channel Angular Pressing (ECAP) of hollow profiles made of titanium. IOP Conference Series: Materials Science and Engineering 194:1-6.
4. Hofstetter J, Rüedi S, Baumgartner I, Kilian H, Mingler et al. (2015) Processing and microstructure-property relations of high-strength low-alloy (HSLA) Mg-Zn-Ca alloys. Acta Materialia. 98:423-432.
5. Krystian M, Bryla K, Horky J, Mingler B (2016) New developments in Equal Channel Angular Pressing (ECAP) of Mg alloys. eCM Meeting Abstracts 2016, Collection 7; 8th Biometal (page 4).

Biography

B Mingler studied physics at the University of Vienna, where he also worked and taught as Assistant Professor mainly in the field of Materials Science. Since 2009 he works at the Austrian Institute of Technology GmbH in the Center for Health & Bioresources. In his function as Senior Scientist and Thematic Coordinator he has his expertise in design and application of biocompatible and biodegradable metals and alloys, their characterization in respect of microstructure, mechanical, corrosive and biological properties as well as in theory and implementation of severe plastic deformation (ECAP, HPT) and characterization of ultrafine grained and nanocrystalline materials. He was the Project Manager of several contract research projects and funded projects and currently heads Research Studio Austria and the strategic lead project. He is co-inventor of several patents dealing with special Mg alloys and ECAP designs and applications

bernhard.mingler@ait.ac.at

Notes:

Kunio Ishikawa, J Biotechnol Biomater 2018, Volume 8
DOI: 10.4172/2155-952X-C1-087

3rd Annual Conference and Expo on

BIOMATERIALS

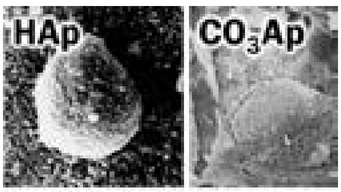
March 05-06, 2018 | Berlin, Germany

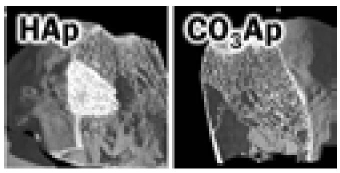
Kunio Ishikawa

Kyushu University, Japan

Carbonate apatite: Next generation artificial bone replacement

Although bone apatite is the carbonate apatite (CO_3Ap) that contains 6-9 wt% carbonate in apatitic structure, hydroxyapatite (HAp) has been used as one of typical artificial bone substitute since CO_3Ap powder start to decompose at 400°C, thus cannot be sintered. We have found that CO_3Ap block can be fabricated by compositional transformation though a dissolution–precipitation reaction using precursors such as calcium carbonate and tricalcium phosphate. Although HAp is not resorbed by osteoblasts, CO_3Ap thus fabricated was resorbed by osteoclasts similar to bone. As a result of osteoclastic resorption, CO_3Ap is replaced by bone whereas HAp remained as it is at the bone defects. CO_3Ap up-regulate differentiation of osteoblasts even when compared to HAp. Figure 3 show the typical Villanueva Goldner staining of HAp and CO_3Ap when used for the reconstruction of bone defect made at the beagle dog mandible. Both HAp and CO_3Ap demonstrated excellent tissue response. However, amount of the bone formed at the bone defect was much larger in the case of CO_3Ap when compared to HAp.





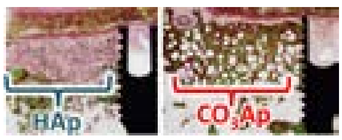


Figure 1: SEM images of HAp and CO_3Ap when osteoclastic cells were incubated on their surfaces.

Figure 2: Micro-CT images of HAp and CO_3Ap when used for the reconstruction of rabbit femur bone defect. 24 months after implantation.

Figure 3: Villanueva Goldner staining of HAp and CO_3Ap when used for the reconstruction of bone defect at the beagle dog mandible. Three months after implantation

Recent publications

1. Ishikawa K, Kawachi G, Tsuru K and Yoshimoto A (2017) Fabrication of calcite blocks from gypsum blocks by compositional transformation based on dissolution–precipitation reactions in sodium carbonate solution. Mater Sci & Eng C, 51:389–393.
2. Shariff K A, Tsuru K and Ishikawa K (2017) Fabrication of dicalcium phosphate dihydrate-coated β-TCP granules and evaluation of their osteoconductivity using experimental rats. Materials Science and Engineering C, 75:1411-1389–393.

3. Fukuda N, Tsuru K, Mori Y and Ishikawa K (2017) Effect of citric acid on setting reaction and tissue response to β-TCP granular cement. Biomed Mater, 12(1):15027.
4. Arifta T I, Munar M L, Tsuru K and Ishikawa K (2017) Fabrication of interconnected porous calcium-deficient hydroxyapatite using the setting reaction of α tricalcium phosphate spherical granules. Cerams Int, 43:11149-11155.
5. Sugiura Y, Tsuru K and Ishikawa K (2017) Fabrication of arbitrarily shaped carbonate apatite foam based on the interlocking process of dicalcium hydrogen phosphate dihydrate. J Mater Sci: Mater Med, 28:122.

Biography

Kunio Ishikawa graduated from Osaka University, Japan in 1985 and got a PhD in 1990. After he worked at Tokushima University as an Assistant Professor he then moved to Okayama University as Associate Professor. In 2001, he became Chairman and Professor of the Department of Biomaterials, Faculty of Dental Science, Kyushu University, Japan. He is also working as a Senior Special Advisor, National Institute of Science and Technology Policy, Ministry of Education, Culture, Sports, Science and Technology, Japan. His interest is in biomaterials aimed for hard tissue regeneration and reconstruction. He was awarded "The Award of Japanese Society for Biomaterials".

ishikawa@dent.kyushu-u.ac.jp

Notes:

Helen Reveron, J Biotechnol Biomater 2018, Volume 8
DOI: 10.4172/2155-952X-C1-087

3rd Annual Conference and Expo on

BIOMATERIALS

March 05-06, 2018 | Berlin, Germany

Helen Reveron

INSA de Lyon - Univ Lyon, France

Mechanical properties of new zirconia-based bioceramics with a metal-like behaviour

Yttria-stabilized (Y-TZP) zirconia ceramics are increasingly used for developing metal-free restorations and are now considered as promising alternatives to titanium as dental implants. Zirconia indeed possesses high strength and good toughness for a ceramic, together with excellent bio-integration, biocompatibility and translucency. However, Y-TZP ceramics are still considered as brittle ceramics, since transformation induced toughening occurs after cracks start to propagate. Moreover, Y-TZP can undergo low temperature degradation (LTD) or ageing, leading to a loss of strength and micro-cracking. Therefore, our current research is focusing on strategies to develop alternative zirconia-based materials with better stability *in-vivo* and higher degree of ductility, especially for dental implants applications in which the translucency is less important but for which a perfect stability, good mechanical properties and long lifetime should be ensured. In this work the mechanical characterization of a new type of very-stable zirconia-based composites is presented. These materials are composed of ceria-stabilized zirconia (Ce-TZP) and two second-phases (alumina and strontium aluminate) and can exhibit very high strength, toughness and ductility. In other words, in these ceramics, plastic deformation occurs before failure driven by the tetragonal (t) to monoclinic (m) zirconia phase transformation, which leads to mechanical behavior laws similar to metals. During the oral presentation, the effect of the composition and/or the microstructure on the strength-toughness relationship will be presented and the validity of various mechanical tests used to measure the fracture strength on these materials discussed.

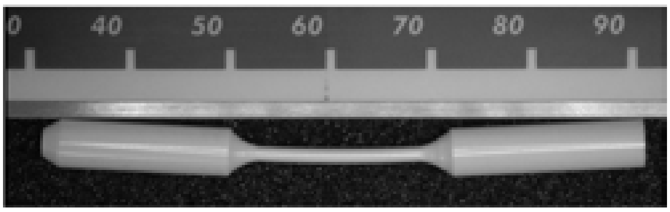


Figure 1: New developed Ce-TZP-based composite plastically deformed.

Recent publications

1. E Apel, C Ritzberger, N Courtois, H Reverón, J Chevalier et al. (2012) Introduction to a tough, strong and stable Ce-TZP/MgAl2O4 composite for biomedical applications. J. Eur. Cer. Soc. 32(11)2697-2703.
2. P Palmero, R Traverso, C Esnouf, H Reveron, J Chevalier, L Montanaro (2015) Zirconia-based composites for biomedical applications: role of second phases on composition, microstructure and zirconia transformability. J. Eur. Cer. Soc. 35(14):4039-4049.
3. P Palmero, M Fornabaio, L Montanaro, H Reveron, C Esnouf, J Chevalier (2015) Towards long lasting zirconia-based nanocomposites for dental implants. Part I: innovative synthesis, microstructural characterization and *in vitro* stability. Biomaterials. 50:38-46.

4. I Touaiher, M Saâdaoui, J Chevalier, H Reveron (2016) Effect of loading configuration on strength values in a highly transformable zirconia-based composite. Dental Materials. 32(9):e211-e219.
5. H Reveron, M Fornabaio, P Palmero, T Fürderer, E Adolfsson et al. (2017) Towards long lasting zirconia-based composites for dental implants: transformation induced plasticity and its consequence on ceramic reliability. Acta Biomaterialia. 48:423-432.

Biography

Helen Reveron is a Research Scientist at the French National Center for Scientific Research (CNRS). Since 2006, she works at the MATEIS Laboratory of INSA-Lyon in the development and characterization of ceramic nanocomposites with controlled micro-nanostructures. Before coming to Lyon, she earned an Engineer's Degree in Materials Science from USB-Caracas-Venezuela (1996) and a PhD in Ceramics and Surface Thermal Treatments from ENSCI-Limoges-France (2000). She then worked as Assistant Professor (Materials Science Department, USB-Caracas) and was interested in the hydrothermal synthesis of oxide nanoparticles, before coming-back to France in 2003. For 3 years, she worked at the ICMCB-CNRS (Chemical Institute of Condensed Matter, Bordeaux, France) in the continuous supercritical synthesis of ferroelectric nanoparticles and the processing/characterization of nanostructured ceramics obtained through SPS (Spark Plasma Sintering). She is the author of more than 35 papers and 5 patents.

helen.reveron@insa-lyon.fr

Notes:

Mohamed Ansari M Nainar, J Biotechnol Biomater 2018, Volume 8
DOI: 10.4172/2155-952X-C1-087

Mohamed Ansari M Nainar
Universiti Tenaga Nasional, Malaysia

Natural/Synthetic hybrid biocomposites: Sustainable materials

Due to environment and sustainability issues, biocomposites have encountered remarkable interest in the last two decades. Also, due to the expanding waste management concerns, natural fibres composites have drawn the attention of many researchers in this field. Hybrid polymer composites have embedded a series of natural and synthetic fibers. Each one has intrinsic characteristics that, when combined to a polymer matrix, achieve a high performance and/or sustainable material [1]. One of the major concern in the composite characteristics is the bonding between the reinforcements and the matrix [2]. Even though numbers of composite materials with synthetic fibres such as glass fibres, rayon, nylon etc. and metallic fibres have been used as reinforcing agent but natural fibres have uniqueness among them because of its extraordinary properties such as biodegradability with significant strength and stiffness [3-5]. The purpose of this talk is to bring awareness among the scientist and researchers on introducing a cost effective and cleaner method of improving the chemical interaction between the natural fibres and the polymer matrix through hybridization techniques and minimize the water absorption problems that usually occur in pure natural fibre based polymer composites. To improve on the properties of natural fiber composites and/or overcome some of their limitations such as moisture absorption, thermal stability, brittleness and surface quality, the concept of hybridization of fibre reinforced composites was used in this study. Jute fibre (JF)/Carbon fibre (CF) and Jute fibre (JF)/Kevlar fibre (KF) hybrid epoxy composites were prepared using Vacuum Press Infusion (VPI) method. Tensile, flexural and impact tests were performed as per the ASTM standard methods. The hybrid composites showed improvement in mechanical properties and reduced water absorption characteristics compared to Jute/epoxy composites. Energy absorption characteristics have shown considerable improvement compared to pure epoxy and Jute/Epoxy biocomposites as shown in Figure 1 (a) – (d).

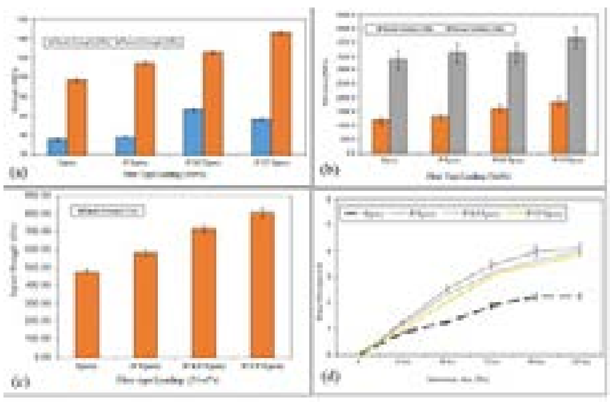


Figure 1: (a) Tensile and flexural strength of hybrid epoxy composites
(b) Tensile and flexural modulus of epoxy composites
(c) Izod impact strength of hybrid epoxy composites
(d) Water absorption of hybrid epoxy composites

References

1. Layth Mohammed, M.N.M. Ansari, Grace Pua, Mohammad Jawaid, and M. Saiful Islam (2015) A Review on Natural Fiber Reinforced Polymer Composite and Its Applications. International Journal of Polymer Science.
2. Wendy Rodriguez-Castellanos and Denis Rodrigue. (2016) Ch15. Production and Characterization of Hybrid Polymer Composites Based on Natural Fibers. "Composites from Renewable and Sustainable Materials", book edited by Matheus Poletto, ISBN 978-953-51-2794-9, Print ISBN 978-953-51-2793-2, Published: November 30, 2016.
3. Daniela de França da Silva Freitas, Sibele P. Cestari, Luis C. Mendes (2017) Ch7. Natural and synthetic fillers for reaching high performance and sustainable hybrid polymer composites. Hybrid Polymer Composite Materials, WP. 157-171.
4. Z.F.Albahash, M.N.M.Ansari (2017) Investigation on energy absorption of natural and hybrid fiber under axial static crushing. Composites Science and Technology.
5. M.N.M.Ansari, Z.F.Albahash (2018) Energy absorption of Jute/Kevlar Hybrid Epoxy Composite. International Conference on Advancement in Polymeric Materials (APM 2018). CIPET, LARPM Bhubaeshwar, India. Feb 2-4, 2018.

Biography

Dr. Mohamed Ansari M Nainar is currently working as Associate Professor of Mechanical Engineering, College of Engineering, Universiti Tenaga Nasional, Malaysia since 2010. He obtained his Ph.D in Polymer Engineering from Universiti Sains Malaysia (USM), Engineering Campus, Malaysia (2009). Dr. Ansari has more than 20 years of teaching, research and industrial experience and has co-authored publications of over 50 research articles in refereed technical journals, 1 book chapter and 1 book to his credit. He has supervised 3 PhD thesis, 15 Master's thesis and 60 undergraduate final year project thesis. Currently, Dr. Ansari serves as a Technical Program Review Committee for Tech Connect World Innovation Conference - USA, since 2012. He is also working as technical reviewer for many reputed journals. He has delivered Invited lectures in many reputed organizations.

ansari@uniten.edu.my

Notes: