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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.

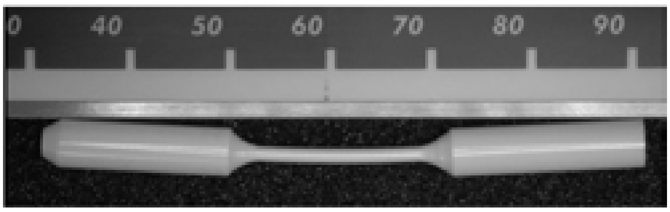

Figure 1: New developed Ce-TZP-based composite plastically deformed.

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.

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