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# How to adjust the mechanical and biological properties of UHMWPE for biomedical purposes by changing the alumina-zirconia content

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Ceramic materials are widespread employed in biomedical application thanks to high strength and wear resistance. Among them, tetragonal $ZrO_2$ shows bioactivity properties, although phase transition towards the monoclinic phase makes it unsuitable for biomedical applications. The problem has been solved by using $ZrO_2$-$Al_2O_3$ composites, for which limited or absent phase transition is observed. However, similar biomaterials still present mechanical properties far to those of hard tissues. A possible strategy to overcome this issue is represented by the dispersion of alumina-zirconia composites in a polymer matrix. In such way it could be possible to obtain an implant easy to be processed, inexpensive, with suitable mechanical properties and good cells interaction. Polymer composites have also the advantage of a contrast adjustable radio-transparency and are compatible with modern diagnostic methods. In this work, different amounts of Alumina Toughened Zirconia (80–20 wt %) (ATZ) have been added to Ultra High Molecular Weight Polyethylene (UHMWPE). The UHMWPE/ATZ composites were prepared by solid state mixing, using a homogenizer, followed by compression molding. The structural, morphological, thermal, mechanical characterization and cells interaction of ATZ-UHMWPE are reported for the first time in order to assess the feasibility of these materials for biomedical tissue reconstruction.

In PE2.5 composite, ATZ particles are uniformly distributed along the "grain" boundaries, whereas at higher concentrations (10 and 20 wt %) they form micrometric agglomerates. The PE2.5 composite has improved elastic modulus and yield stress respect to bare UHMWPE. For all the other composites, an increase in the elastic modulus respect to neat UHMWPE is observed, although the other mechanical parameters are reduced by increasing ATZ content. The results can be explained in terms of poor dispersion of the oxide in the polymer matrix at concentrations higher than 2.5 wt %. Furthermore, the good dispersion of ATZ seems to positively affect the cells adhesion and protein adsorption (using Bovine Serum Albumin, BSA).

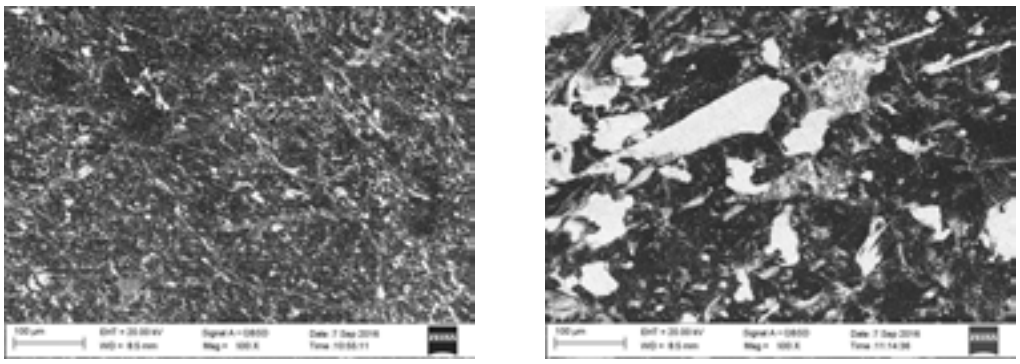

*Figure 1: Dispersion of the ceramic phase into the polymer matrix at different ATZ percentages, i.e. 2.5 wt % (left); 20 wt % (right).*

**Notes:**

**Recent Publications**

1. Mussano F, Genova T, Rivolo P, Mandracci P, Munaron L, Faga M G and Carossa S (2017) Role of surface finishing on the in vitro biological properties of a silicon nitride–titanium nitride (Si3N4–TiN) composite. Journal of Materials Science 52: 467-477.
2. Tebaldo V and Faga M G (2017) Influence of the heat treatment on the microstructure and machinability of titanium aluminides produced by electron beam melting. Journal of Material Processing Technology 244: 289-303.
3. Duraccio D, Mussano F and Faga M G (2015) Biomaterials for dental implants; current and future trends. J Mater Sci 50: 4779–4812.
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5. Vallée A, Faga M G, Mussano F, Catalano F, Tolosano E, Carossa S, Altruda F and Martra G (2014) Alumina-zirconia composites functionalized with laminin-1 and laminin-5 for dentistry: Effect of protein adsorption on cellular response. Colloids and Surfaces B: Biointerfaces 114: 284-293

## Biography

Maria Giulia Faga is a Researcher of the National Research Council of Italy (CNR). Her research activity ranges from physico-chemical study of catalysts to the functionalization of massive materials (oxidic composites) for biomedical applications to the study of tribological and surface properties of wear resistant thin films for cutting tools. At present, she is responsible for the institute activity "Machining and characterization of materials for mechanical, wear resistance and biomedical applications" and responsible of the laboratories for mechanical and tribological properties of thin layers and bulk materials. Her research interests include the following laboratory skills: wear and mechanical characterisation of materials (tribometer, scratch test, durometers); microstructural (SEM-EDS) and spectroscopic (Raman, FTIR, UV-Vis, XRD) analysis. She cooperates mainly with the Chemistry group of University of Turin, the Materials and Machining Departments and the Department of Management and Production Engineering of Polytechnic of Turin.

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