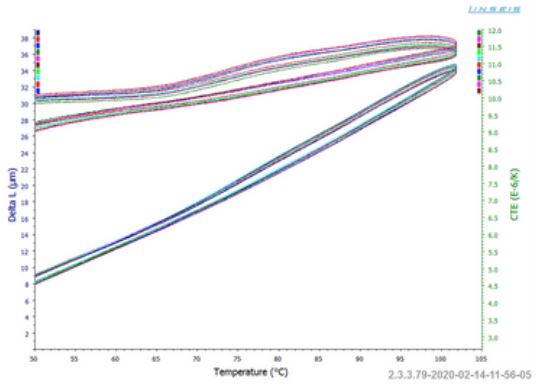
ADDITIVE MANUFACTURING OF CUSTOMIZED CERAMIC DENTAL IMPLANTS SUBSEQUENTLY JOINED WITH BIODEGRADABLE METAL CORES

-NEWSLETTER 3-

During the project's second year of realization, T2.2 and T2.3 tasks were realized to further develop the manufacturing process of interconnected metal-ceramic composites for Mg-based teeth implants. Two infiltration methods were continued to be utilized: squeeze casting and investment casting. Ceramic 3D-printed preforms, fabricated with other pore agents and core shapes, obtained from NTUT in WP1 were saturated with metal to achieve a proper degree of filling with high quality interface. Both beam-like and teeth samples were used. Thermal expansion tests were conducted on ceramic, metal and composite samples, proving a beneficial influence of ceramic part on supressing the elongation of a metal core during heating. Reinforcement effect was assessed in relation to the Mg alloy. As for this constituent, firstly applied AZ91 alloy, due to the high content of Al which is potentially harmful for human body (causing neurodegenerative consequences), was decided to be replaced with Mg-3Zn alloy, which should be also corrosively resistant and does not contain Al.

Both infiltration methods can be used for successful saturation of ceramic scaffolds with Mg alloy. Nevertheless, the squeeze casting technique, although superior in terms of the applied pressure and quality of connection between composite elements, causes severe difficulties during machining of the cast part from the mould, what can lead to the possible cracking and destruction of the finished part (especially when complex shapes are considered. In spite of this, the investment casting was selected as more preferable. After casting parts can be further treated (polished) to obtain higher accuracy.



CTE and dL for an exemplary composite - 10 runs, 50-100C


Tooth infiltrated with Mg alloy and polished

After multiple casting trials were done, an attempt of thermal expansion evaluation was undertaken. Dimensional stability, characterizing the reinforcement effect exhibited by composites in relation to the pure Mg properties, was greatly increased for all of the composite samples – concluding from reduction of 1.5 to 3.5 times for dL and 1.5 to 3.9 times for CTE. Even after a higher number of runs (e.g. 15) the tested specimens didn't show any signs of detachment or cracking (visual inspection), confirming a sufficient thermal stability. Several model predictions were considered (rule of mixture, Turner and Kerner) to be in good agreement with the obtained values. CTE measured at 100C for composite materials belonged to the range of approx. 7-18 E-6/K, while for Mg and its alloys it equals approx. 26 E-6/K. In the next step, the mechanical properties will be established. Some of the results mentioned here were presented during The 8th International Conference on Magnesium (ICM 8) and The International Conference on Magnesium Alloys and Their Applications (Mg 2024) in the presentation "Elaboration of manufacturing technology of Al2O3-Mg alloy composites for customized biodegradable teeth implants" (2-6.11.2024, Chongqing, China).

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