



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

-NEWSLETTER 2-

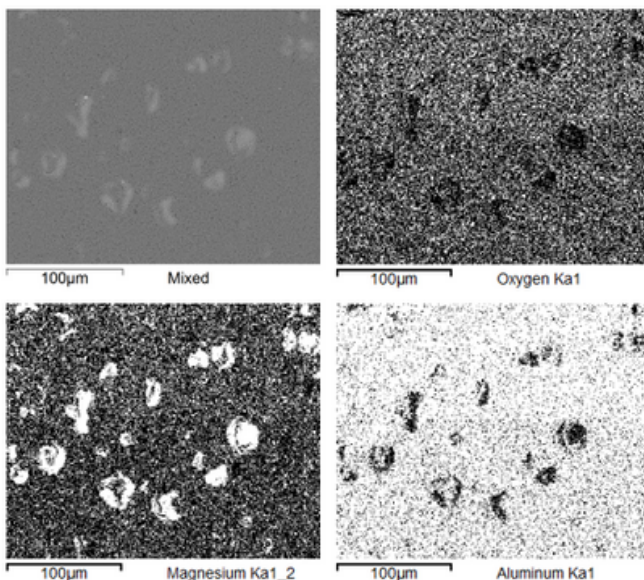
REALIZED TASKS

During the project's first year of realization, two tasks were completed from WP1 and WP2: T1.1 and T2.1. In T2.1, two infiltration methods were tested: squeeze casting and investment casting. The first method to be utilized was squeeze casting. Samples with different material compositions and different degrees of porosity were infiltrated. The base material for the preforms was Al₂O₃ ceramics.

After squeeze casting, the samples were prepared for microscopic observations (grinded, polished and sputtered with graphite) and then subjected to SEM analysis with Hitachi 3400N scanning electron microscope equipped with SwiftED3000 energy-dispersed X-ray spectrometer.

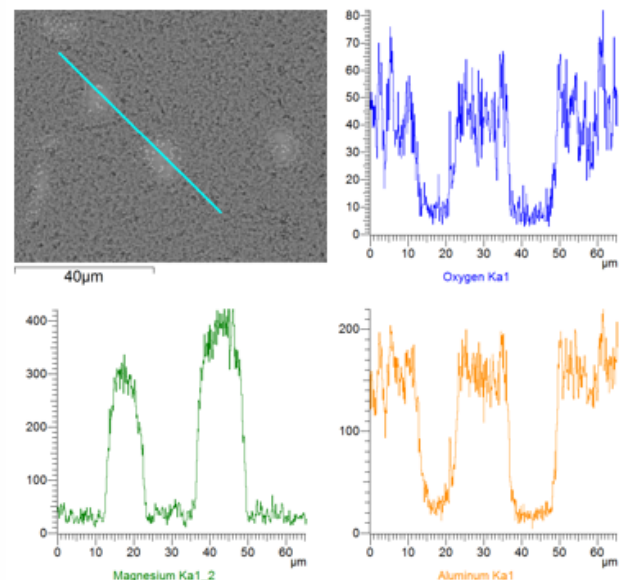
RESULTS

During the preliminary attempts, infiltration of samples A and H was only partially successful. The large porosity was infiltrated, while the internal one wasn't, probably due to the too low pressure. However, samples P1 and P2 were successfully infiltrated. In sample P1, only some of the internal porosities were saturated with metal, while in case of sample P2 the infiltration was throughout.

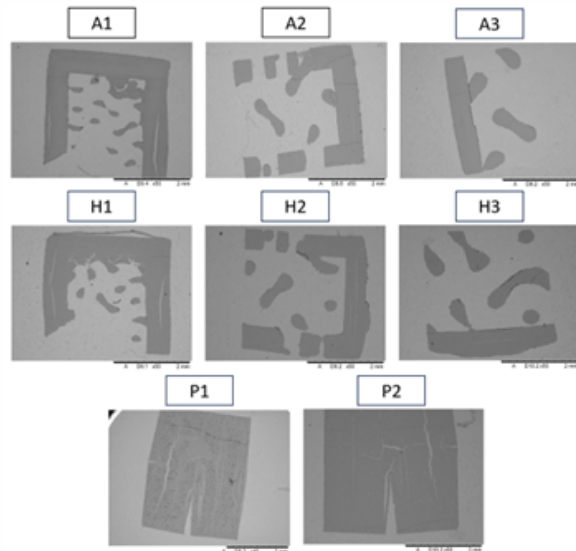


Mapping of elements distribution for
sample P2

After SEM tests, the porosity of the samples was also determined. The project proposal assumed a residual porosity of 1 – 2%. All infiltrated samples had a porosity of less than 1%.

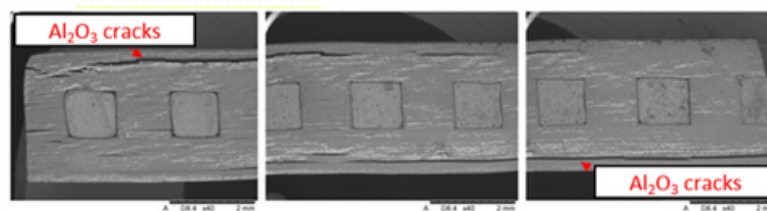


Linear EDS analysis of sample P2



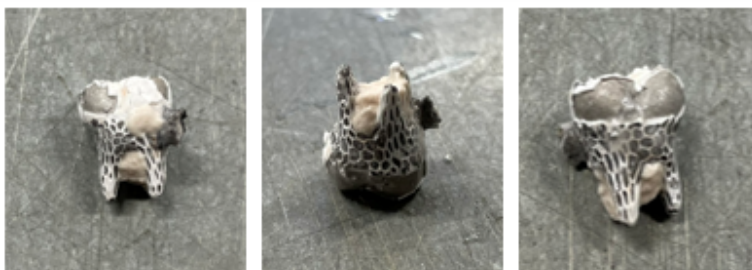
SEM images of samples after the first infiltration using the squeeze casting method

Afterwards, for the investment casting method, ceramic beams with different pore sizes were used. Most of the trials were successful. However, there were instances where cracks were observed throughout the ceramic preform. They were arranged in the same way as the individual layers were deposited during the additive manufacturing of the preforms. It is possible that this type of damage was caused by too high temperature during firing or the parameters of the infiltration process, such as the temperature of the metal during pouring.



SEM images of Al₂O₃ beams; visible cracks in the ceramic preform

In the first trial, ceramic tooth has been completely infiltrated. It was observed that the solid section of the preform, which mimics the tooth crown, was detached. This damage probably occurred during pouring with liquid metal.



Ceramic tooth after infiltration - first attempt



Ceramic tooth after infiltration - second attempt

CONCLUSIONS

The conducted tests showed that the squeeze casting method was effective only for samples belonging to group P, characterized by the best filling of both large and fine (internal) porosities with liquid metal. The use of the investment casting method to infiltrate simple ceramic preforms was also successful - the preforms were fully infiltrated. In the next stages of the project, an attempt should be made to infiltrate gradient ceramic structures using the investment casting method as well.