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EFFECT OF HOT PRESSING VARIABLES ON THE STRENGTH AND POROSITY OF COCRMO ALLOY POWDER COMPACTS

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ABSTRACT

The purpose of this study was to evaluate the effect of processing parameters on the mechanical properties of hot pressed CoCrMo samples.

CoCrMo alloy substrates were obtained by hot pressing technique. The microstructure was investigated by Optical Microscopy (OM) and the porosity level was determined by image analysis. Hardness tests were carried out on a micro hardness indenter. Young's moduli measurements were determined using a DMA equipment. The transverse rupture strength (TRS) of hot pressed specimens was also obtained.

The results showed that the mechanical properties and porosity were influenced by the hot pressing process parameters, hot pressing time and temperature, especially when low hot pressing periods (10 min) and low temperatures (900˚C) were used. Higher hot pressing temperatures and times showed to positively impact the mechanical properties of the hot pressed compacts, mainly due to a decrease in porosity.

Powder metallurgical (P/M) products are steadily increasing their relevance in the biomedical field due to their enhanced properties relative to conventionally obtained counterparts. Therefore the new data brought by this study is believed to be very useful in the design and processing of hot pressed CoCrMo compacts for biomedical applications.

Keywords: CoCrMo alloy, hot pressing technique, powder compacts, biomedical applications.

INTRODUCTION

Cobalt-chromium alloys, along with titanium alloys and stainless steel, are among the few alloys currently used in biomedical applications, and particularly for making surgical implants (Pilliar, 2009). Co-Cr alloys display high strength, high corrosion resistance and are biocompatible. Therefore, they are used in biomedical applications such as orthopaedic implants, dental implants, dental restorations, among others. Co-based alloys products are often obtained by conventional methods such as casting or forging. Nevertheless, new powder metallurgy (P/M) methods are being explored, as they can result in near-net shape parts with enhanced mechanical and electrochemical properties (Henriques et al., 2012). The finer microstructure thus obtained and the lack of porosity are the main features of these methods, and it has been shown that the properties of P/M products are comparable with those of the wrought alloys (Patel et al., 2010; Dewidar et al., 2006). . The powder metallurgy processing routes, such as laser sintering, hot isostatic pressing, press and sinter, and MIM (metal injection moulding) have been already employed in the fabrication of CoCrMo biomedical

parts (Pilliar, 2009). This work was devoted to the study of the influence of the processing parameters that govern the hot consolidation of powders (namely time and temperature) on the mechanical properties of hot pressed CoCrMo powder compacts.

RESULTS AND CONCLUSIONS

The results from the Young's moduli measurements are presented in Fig. 1.

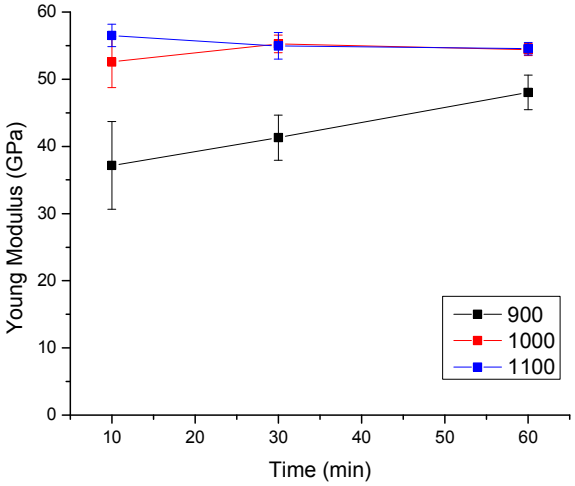

Fig. 1 - Young's Moduli of hot pressed CoCrMo powder compacts for different processing conditions.

Results showed that the tested hot pressing parameters, time and temperature, influenced the mechanical properties and porosity of the hot pressed specimens. Low hot pressing temperatures (900ºC) and short hot pressing times (10min) showed to result in samples with high porosity and low mechanical properties. These findings are shown Figure 1 where significant differences in Young's moduli were found between the samples hot pressed at 900ºC and those hot pressed at 1000ºC and 1100ºC. Similar trend was found in terms of hardness measurements, with the samples hot pressed at 900ºC exhibiting the lowest hardness values.

REFERENCES

[1]-Pilliar RM. Metallic Biomaterials. In: Pilliar RM (ed) Biomedical materials. Springer, Berlin 2009 p.41-81.

[2]-Henriques B, Soares D, Silva F. Microstructure, hardness, corrosion resistance and porcelain shear bond strength comparison between cast and hot pressed CoCrMo alloy for metal-ceramic dental restorations. J Mech Behav Biomed Mater, 2012, 12 p. 83-92.

[3]-Patel B, Inam F, Reece M, Edirisinghe M, Bonfield W, Huang J, Angadji A. A novel route for processing cobalt-chromium-molybdenum orthopaedic alloys. J R Soc Interface, 2010. http://dx.doi.org/10.1098/rsif.2010.0036.

[4]-Dewidar MM, Yoon H, Lim JK. Mechanical properties of metals for biomedical applications using powder metallurgy process: a review. Met Mater Int, 2006, 12 (3) p.193-206.