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Evaluation of the stability of face coated molds for investment castings of titanium

C. Bolfarini(1)*, C. S. Kiminami(1), W. J. Botta Filho(1), R. D. Cava(2), D.P. Oliveira(2)

(1) Departamento de Engenharia de Materiais, Universidade Federal de São Carlos, Rod. Washington Luis, Km 235, Cx. 676 São Carlos-SP Brasil, e-mail: cbolfa@ufscar.br

(2) Programa de Pós graduação em Ciência e engenharia de Materiais, Departamento de Engenharia de Materiais, Universidade Federal de São Carlos, Rod. Washington Luis, Km 235, Cx. 676 São Carlos-SP Brasil, e-mail: oliveira_pedreira@hotmail.com.

* Corresponding author.

Abstract – Titanium samples were melted and poured using a centrifugal casting machine and ceramic molds face coated with oxides powders and binders, both with high thermodynamical stability. The effect of the face coat material was evaluated with metallographic analyses, SEM/EDS and microharness measurements.

It is well known that the surface regions of investment castings of Ti alloys are subjected to contamination due to its high reactivity with the ceramic molding materials during the solidification and cooling process. This contamination is called *hardened alpha case* and the principal contaminant is the oxygen from the ceramic molds that interstitially dissolves in the crystalline structure of titanium. Since the thin wall of the metal is formed, a diffusion profile is formed from the surface of the metal during solidification and cooling, Figure 1 shows through the microhardness number the profile hardened. This event can cause some defects in the surface of the as-cast materials, culminating in the reduction of both: ductility and fatigue resistance [1]. These circumstances reduce the possibility for using this process on the fabrication of biomaterials, such as orthopedic implants.

Thereby, trying to prevent these defects, melts of titanium CP were carried out, using an induction furnace with a ceramic crucible and the metal was poured in some molds by centrifugal force. The small molds were previously face coated with a mixture of powders, binder and deionized water. The refractory oxides selected were alumina and yttria, both high stable thermodynamically [2]. As binder for these powders were applied colloidal suspensions of silica or alumina.

The samples obtained were investigated by metallographic analyses. In addition, Vickers micro hardness measurements were carried out for investigating the thickness and the hardness magnitude of the *hardened alfa case*. SEM analyses were carried out on the region contaminated of the samples.

Analyzing the hardness profile, it could be noted that a similar curve was obtained for different molds (oxides plus binder) related to the hardened layer thickness. However, the molds using a higher thermodynamic stability combination of binder and oxides presented shorter Vickers numbers.

The pair Yttria/Alumina colloidal induced less than 350 HV and Alumina/Alumina colloidal less than 720 HV on the surface of titanium as cast, for instance.

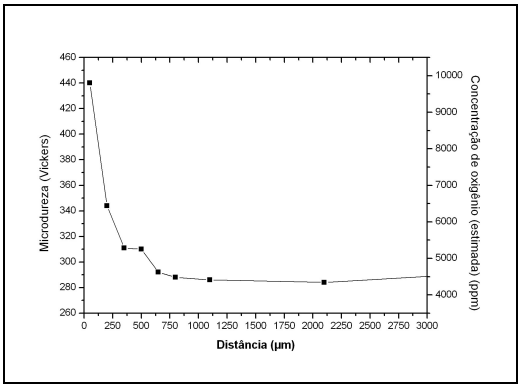

Figure 1: Microhardness (Vickers) and oxygen concentration estimated (ppm) of titanium casted in a yttria and silica mold.

References

[1] Boettinger, W., et al., "Alpha Case Thickness Modeling In Investment Castings". Metallurgical and Materials Transactions B, 2000. 31(6): p. 1419-1427.

[2] Saha, R., et al., On the evaluation of stability of rare earth oxides as face coats for investment casting of titanium. Metallurgical and Materials Transactions B, 1990. 21(3): p. 559-566.