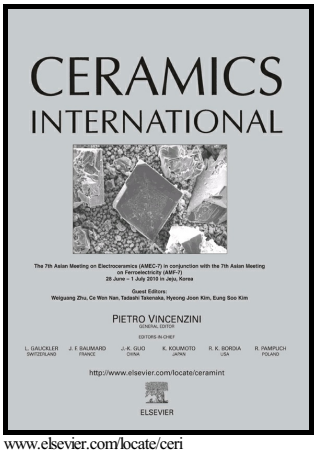

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Silica-free investment casting molds based on calcium zirconate

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Abstract

Investment casting allows the near net shape production of complex cast parts, but the investment casting of high melting and highly reactive titanium alloy melts is very difficult. Calcium zirconate ($CaZrO_3$) is a novel ceramic refractory material, which is particularly stable in a highly reducing atmosphere and in contact with extremely reducing titanium alloy melts such as Ti6Al4V. Besides the refractory, the choice of the binder is equally important because conventional silicate binders significantly impair the corrosion resistance. Although there have been successful attempts to develop $CaZrO_3$ investment casting molds, silica-free $CaZrO_3$ investment casting molds using a water-based binder have not yet been reported.
For the first time, $CaZrO_3$ investment casting molds using a silica-free water-based binder system were successfully produced. Moreover, the rheological behavior of the slips and the chemical, physical and microstructural properties of the molds were extensively described. Investment casting of Ti6Al4V led to an exceptionally low hardness increase of the cast part, suggesting that only a slight corrosion reaction took place. Thus, the silica-free $CaZrO_3$ investment casting molds contributed to an improved investment casting of titanium alloys.

Keywords: E. Refractories; D. Perovskites; C. Corrosion; A. Shaping; Investment Casting

1. Introduction

Titanium alloys play a key role in aerospace as well as in biomedical and chemical industries due to their high strength combined with a low density and an excellent corrosion resistance [1]. Investment casting is a profitable technology for the near net shaping of complex cast parts. During casting, a ceramic refractory mold, which is produced by the lost-wax process, is filled with the liquid metal melt. After solidifying, the ceramic mold is removed by breaking the shell [1]. Fig. 1 provides a general model of the ceramic coats produced by dip-coating and stuccoing on the wax pattern.
Despite the many benefits of titanium alloys, a central problem is the high reactivity and the high melting point of the melts, which requires a corrosion resistant refractory material with a high melting point. Thus, many studies in recent years focused on the development of refractory materials for titanium alloy melts [2–10]. Yet, conventional refractories such as Al_2O_3, SiO_2, ZrO_2, CaO and Y_2O_3 were not sufficiently corrosion resistant. Y_2O_3 showed generally the best behavior but the melt was still contaminated by the precipitation of insoluble yttrium as Y_2O_3 [3]. It is also the most expensive

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