Effect of Additives on Sintering Response of Titanium by Powder Injection Molding

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Powder injection molding is a newer technology which is highly useful for the production of complex metallic and non-metallic parts of various sizes. Considering the advantageous properties of titanium in automotive applications, components manufactured from low cost sponge titanium powder are more economical. This paper describes the preparation of Ti compacts with and without addition of additives, zirconium and iron, using the powder injection molding (PIM) process. Differential scanning calorimetry (DSC) was used to optimize the sintering cycle. The samples were sintered at 1,275°C and 1,300°C in a high vacuum furnace for hold times of one hour and two hours. The performances of the compacts were studied using tensile testing, hardness testing, and scanning electron microscopy (SEM). The strengths and weaknesses of the test conditions have been analyzed from the densification behavior, microstructure, and mechanical properties.

High-Performance Injection Molded Ti-6Al-4V Alloy Materials added Mo, Fe, Cr

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Ti and its alloys have been widely used for various industrial and medical applications because of their excellent characteristics of low density, high strength, high corrosion resistance and high biocompatibility. However, it is not easy to produce the complicated shape and precise parts because of their poor workability. Therefore, the advanced powder processing techniques such as Metal Injection Molding (MIM) are hoped to be a suitable technique for fabricating complex shaped Ti or its alloy parts with low cost. In this paper, various high performance Ti alloy materials such as Ti-6Al-4V added Mo or Fe or Cr have been developed by MIM process. The effect of powder type and sintering conditions on the microstructures, relative density and mechanical properties of injection molded compacts were investigated. Also the oxygen and carbon contents were checked in detail for obtaining high performance properties as same as the wrought materials. Eventually, more than 1,000 MPa of strength and 15% of elongation were achieved with MIM process.

Titanium and Titanium–Nickel Parts Processed by PIM of TiH₂–Based Feedstocks

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Titanium and Titanium-Nickel parts have been processed from titanium hydride and blends of titanium hydride and elementary nickel powders respectively. PIM feedstocks were processed in sigma blade mixers by using binders composed of low density polyethylene, paraffin wax and stearic acid. A two-step debinding process has been used, which consists of solvent debinding in heptane at 50°C (122°F) followed by thermal debinding in a MIM furnace at 500°C (932°F) under argon atmosphere. Dehydrogenation of TiH₂ powder is performed simultaneously with thermal debinding. Titanium parts were sintered at 1,200°C (2,192°F) under argon. The mechanical properties of sintered parts were measured by tensile tests. The microstructure was characterized by optical metallography and scanning electron microscopy. Special care in powder handling, feedstock preparation, debinding and sintering atmospheres, allowed to obtain low residual oxygen, nitrogen and carbon contents, which were determined by quantitative analysis. Watch-bracelet segments were injection molded as test parts, showing good shape preservation and reproducibility. Titanium–nickel shape memory alloys were sintered at 1,200°C (2,192°F) under hydrogen. Differential scanning calorimetry revealed the presence of a reversible martensitic transformation above room temperature. Shape memory effects of more than 4% have been measured.