

L. Ti-6Al-4V Billet Feedstock Manufacture and Evaluation

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Objectives

- Develop low-cost Ti-6Al-4V billet feedstock using a blend of titanium (Ti) and alloy powders and inexpensive Ti-6Al-4V machine turnings, or using 100% turnings.
- Evaluate this low-cost Ti alloy feedstock as a starting billet material for casting, forging, and extrusion operations.

Approach

- Develop a procedure for producing low-cost Ti billet using a combination of inexpensive Ti alloy machine turnings and Ti and alloy powders, or 100% machine turnings. Evaluate the billet for density and microstructure.
- Subject the feedstock billets to casting, forging, and extrusion operations. The three operations will yield Ti-6Al-4V test bars.
- Evaluate the quality of the test bars produced through chemistry and mechanical testing.

Accomplishments

- Produced a high-density billet containing 60% turnings/40% Ti alloy powder that was produced using a core of 100% turnings, surrounded by a “can” made from Ti alloy powder.
- Produced a billet using 100% turnings, achieving full density, using cold+hot isostatic pressing (CHIP) technology with conventional canning in mild steel for the HIP operation.
- Extruded a billet, composed of 100% turnings surrounded by a “can” made from Ti alloy powder, to high-density barstock.
- Demonstrated that billets of 100% Ti-6Al-4V machine turnings can be successfully cast from billets in the sintered condition, without the additional step of HIP of the billet. The resulting castings demonstrated tensile strength and ductility that met or exceeded the typical properties of Ti-6Al-4V castings.

Future Direction

- Produce an additional extrusion billet, using specially selected and processed high-quality Ti-6Al-4V turnings (according to the process now developed), that will maintain oxygen content at 0.25% maximum.
- Increase the parameters for consolidation. A higher HIP cycle (temperature, hot pressing temperature, and time) will be employed to produce a higher-density feedstock (full density will be the target).
- Increase the extrusion reduction ratio so that a 5-in.-diameter billet will be extruded to a 1-in.-diameter bar (25:1 extrusion ratio).
- Evaluate the resulting test bars for chemistry and tensile properties.

Introduction

Dynamet Technology is developing a novel method of producing low-cost Ti alloy billet from Ti scrap turnings by powder metallurgical processing. Dynamet’s process consists of consolidating the turnings using a combination of cold isostatic pressing and vacuum sintering, followed by HIP, if necessary (Figure 1). The result is feedstock that can be used as extrusion billet, forging stock, or casting electrodes. This process promises to produce billets that are a low-cost alternative to billets produced from ingot.

and reduce emissions. Indeed, the availability of low-cost Ti would make Ti attractive to any industry that can benefit from the metal’s advantages as a structural material. In addition to the energy, environmental, and economic benefits that result from vehicle weight reduction, the recycling of Ti turnings through Dynamet’s process would result in significant energy reduction because it would supply low-cost Ti for new applications that would not require new Kroll process sponge as a raw material.

Future Direction

To complete the promising aspect of this highly desirable concept, it is necessary to successfully extrude Ti-6Al-4V turnings to produce barstock meeting the conventional Ti-6Al-4V mechanical properties. Based upon what we have learned thus far, it is believed that such successful extruded product can be demonstrated. A supplementary program to accomplish this goal has been designed.

At the completion of this supplementary study, a detailed effort would be proposed to lead to commercialization of a low-cost specific grade of Ti-6Al-4V manufactured using processed turnings emanating from Ti-6Al-4V machining operations. This effort will not only generate a low-cost product but also use an energy-efficient and environmentally beneficial manufacturing process.

Publications

Dynamet Technology, Inc., *Ti-6Al-4V Billet Feedstock Manufacture and Evaluation—Final Report*, Burlington, MA, July 15, 2004.

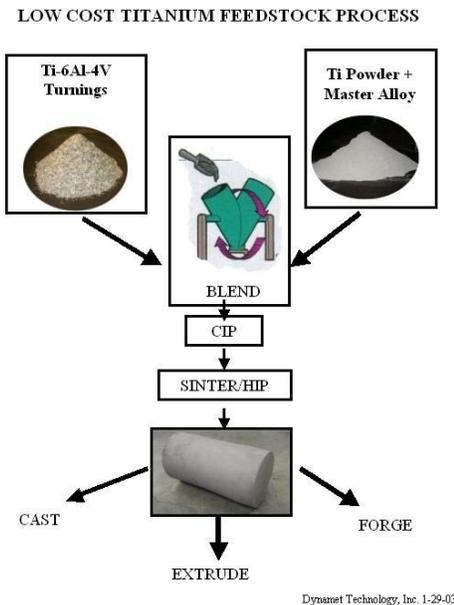


Figure 1: Dynamet’s CHIP process for producing low-cost feedstock.

The use of low-cost billet made by Dynamet’s process in manufacturing Ti alloy parts for heavy-duty vehicles will save energy, increase payloads,