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Technical Report

Titanium alloy production technology, market prospects and industry development

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ABSTRACT

Titanium alloy with a low density, high specific strength, corrosion resistance and good process performance, is the ideal structural materials for the aerospace engineering. Based on the microstructure of titanium alloys, it can be divided into α-type titanium alloys (heat-resistant titanium alloys), β-type titanium alloys and α + β-type titanium alloys. The research scopes also include the fabrication technology of titanium alloys, powder metallurgy, rapid solidification technology, and other military and civilian applications of titanium alloys. Titanium and its alloys have become the ideal structural materials used for the fuselage, and accounted for a significant part of the structural quality in most military aircrafts. Titanium's future market expectations need to be considered in the macro level market. Apart from the supply and demand trends of titanium market, it is necessary to consider the impact of technological innovations that can help to reduce the cost of titanium production.

1. Introduction

Titanium element as a matrix by adding other elements is known as titanium alloy. Titanium is a new structural material, which has excellent comprehensive properties, such as the low density (4.5 g/cm^3), a high specific strength and fracture toughness, fatigue strength and resistance to crack propagation, good low-temperature toughness and excellent corrosion resistance. Some titanium alloys' maximum working temperature is about 550 °C, and expected to reach 700 °C [1]. Therefore, titanium alloys has been increasingly widely used in aviation, aerospace, chemical, shipbuilding and other industrial departments [2]. Compared with light alloys and steel, etc., as for the relationship between specific yield strength and density ($\sigma_{0.2}$/density), titanium alloys is higher than other light metals, steel and nickel alloys, and this advantage will be maintained until about 500 °C, so some titanium alloys suitable for the manufacture of gas turbine engine components [3]. Titanium production in about 80% is for aviation and aerospace industry. For example, in the United States, titanium is approximately 21% of B-1 bomber's body structure material, mainly for the manufacture of the fuselage, wings, skins and load-bearing component. For the F-15 fighter structural materials, titanium alloys occupy a capacity of 7000 kg, which is about 34% structural weight of the airframe [4]. For Boeing 757 aircraft structural parts, titanium alloy with a capacity of 3640 kg is 5% of structural weight. As for DC10 aircraft produced by Mc-Donnell–DounLas, used titanium alloys reached 5500 kg, accounting for more than 10% of its structural weight. The application level of titanium in the chemical and general engineering fields accounts for about 15% of its production in USA [4,5]. Titanium and its alloys, due to their excellent corrosion resistance, good mechanical properties as well as histocompatibility, are qualified for the production of prosthetic devices and other biological materials [6–8].

Titanium with a low density of 4.5 g/cm^3 is only 60% of iron's density, usually with aluminum and magnesium is known as the light metals. Many countries in the world recognize the importance of titanium alloy materials, so titanium alloy materials are being on the research and developing, and supported by practical application [5,9,10].

Titanium and titanium alloy, as important structural metals and alloys, were developed in the 50s of twentieth century. Titanium alloys are provided with a high specific strength, good corrosion resistance, high heat resistance, easy soldering and other characteristics, so which has been widely used in various fields [11]. In particular, titanium alloys are conducive to the manufacture of golf club head because of their characteristics of high strength and easy welding performance.

The first practical titanium alloy "Ti–6Al–4V alloy" was successfully developed in 1954 in the United States. The properties of Ti–6Al–4V alloy in heat resistance, strength, plasticity, toughness, formability, weld-ability, corrosion resistance and biocompatibility are up to a better level. Ti–6Al–4V titanium alloy's consumption accounted for the 75–85% of all kinds of titanium alloys. Many other titanium alloys can be regarded as Ti–6Al–4V alloy modified. At present, hundreds of kinds of titanium alloys have been developed in the world, and the most famous alloys are 20–30 types. For example, there are Ti–6Al–4V, Ti–5Al–2.5Sn, Ti–2Al–2.5Zr, Ti–32Mo, Ti–Mo–Ni, Ti–Pd, Ti-811, Ti-6242, Ti-1023, Ti-10-5-3,

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