MICROSTRUCTURE PROPERTIES OF (α+β) TITANIUM ALLOYS: A REVIEW

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ABSTRACT

The aspiration of this paper is to establish and verify the relationship between the two phases of the titanium alloys production and phases of the alloy is considered as (α+β) phases, the relationship between (α+β) phases verify upon the basis of microstructure as well as mechanical properties. However, a few of the essential properties as yield stress, creep, ductility, HCF and LCF also optimized for the important micro structural utilities of the titanium alloy, and although both processing and microstructure include several variables, it can be shown that only some of the discussed base correlation of the application is possible. There is one more relationship between the properties such as cooling rate, slip phenomenon and colony size discussed and relate with the and compare with two phases of the alloy for insensitive and reproducible path. In order to produce a bi-lamellar structure, coarse and complete lamellar structure enhanced through by application of the an annealing heat treatment procedure that lead to transformation of the all β phases into hard lamellar fine α phases.

Keywords : (α+β) titanium alloys, annealing , heat treatment ,Microstructure, titanium alloy.

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1. INTRODUCTION
Titanium alloy with high strength has been found in nature typically in \((\alpha+\beta)\) alloys and exist in two phases. Such alloy have mechanical properties which extremely reactive to the microstructure and in lot of cases also as hexagonal phase of crystallographic texture, and both based on the nature of the manufacturing way use in the manufacture of the basic components[1][2].

The current paper aims to highlight a number of of the essential micro structural application, such as volume Fraction as well equiaxed primary \(\alpha (\alpha_p)\), continuous a micro structural boundaries at \(\beta\) grain boundaries , lamellae size and to link to a significant processing measures such as procedural measures as processing temperature, material recrystallization point and refrigeration.

The mechanical characteristics take into consideration are ductility, nucleation, fatigue crack propagation, creep and fracture resilience and up to a mark able limit environmental sensitivity. The current narrative concentrates upon two important micro structure types such as bi modal as well as lamellar micro structure. There are several example of the titanium alloys such as Ti-6141, IMI 726 and Ti–6Al–4V[3].

Bi-modal micro structures display a alloy element portioning consequence, lessening the fundamental strength for lamellar phases grain on bi-modal arrangement lower than the strong point of micro structure of fully lamellar. In case of the bi-lamellar, the mechanical properties of completely lamellar of course structure enhanced upon the heat treatment process by transforming all single phase lamellar layers into fine platelets. The results calculated on the Russian VT 25y alloy's bi-modal microstructure indicate that it have been applied that bi lamellar principle as the lamellar phases of bi modal  producing that might be known as trimodal or triplex microstructure kind.

2. METHODOLOGY
2.1. Processing and microstructure
2.1.1. Bi-modal microstructure
A standard processing route is exposed schematically in Fig. 1 to achieve a supposed bi-modal (duplex) microstructure. Where, separating the procedure into four dissimilar steps: \(\beta\)-phase homogenization (I), \(\alpha+\beta\) phase deformation (II), \(\alpha+\beta\)-phase recrystallization (III) and lower-temperature aging (IV)[4].

![Fig.1 Schematic diagram for processing route of bi model](image-url)
The cooling rate is the most important parameter in deciding the homogenization temperature which determines the breadth of $\alpha$-lamellar within lamellar structure. In Fig. 2, effect of the cooling rate on the lamellar structure has been shown at different temperature[5].

![Cooling Rate Effect](image)

**Fig. 2 Cooling rate effect on the $\beta$ phase field on lamellar microstructures, (a) 1$^\circ$ C/min (b) 100$^\circ$ C/min (c) 8000 $^\circ$/min**

During the study the temperature of the homogenization is keeping as low as possible according to characteristics of the process, but in contrary grain size kept at large. In stage II, as shown in fig. 2, lamellar structure just get deformed rather than broken. During the stage III, plastically deform metal is keeping large as possible as but dislocation will occur at large to boost the recrystallization of the microstructure phases. In hexagonal as well as BCC phases, it is possible to shown a crystallographic texture [6].

Fig. 3 shows a number of the textures that be able to be shaped schematically. The recrystallization temperature of the deformation calculates the type of texture. Basal or transverse types (B/T) of texture exhibits at low temperature, whereas T texture growth at increase temperature also sometimes. The degree of Plastic deformation defines the strength of the texture while the mode of deformation determines the symmetry of the texture (Fig. 3). During the subsequent recrystallization stage III, the resultant textures of the process will not modify considerably[7].

![Textures](image)

**Fig.3 Crystallographic textures formed in (α - β) titanium alloys**

Temperature is the one of the basic parameter in the recrystallization phase III, recrystallized equiaxed $\alpha_p$ uses it volume fraction for the cooling rate after the recrystallization, and one of the main outcome of this process is the built of the individual lamellar layer along with a colony lamellar structure. The resultant bi-modal structure is able to be seen as a typical example in Fig. 4.
It should be noted that if the recrystallization temperature cooling rate is adequately low, only $\alpha_p$ grains can expand as well no lamellae layers are produced inside the b grains consequential in material structure through the balance of b grains volume fraction that positioned at the' triple-points' of a grain. Such microstructure is too created during the process of the formation of the new crystallization, for instance 798°C for Ti–5Al–6V, is sufficiently low. The apparatus that adjusts the distorted lamellar' loading' arrangement to equiaxed grains in this case is the repeal and a step penetrate the recrystallized $\beta$-lamellae along $\beta$ / $\beta$ grain boundaries[6]. It has been shown in the Fig.5[8].

The resultant $\alpha_p$ size is primarily determined by the breadth of the' ending' structure a lamella, which implies the cooling in the b stage in first step (Fig 1). That is demonstrated with the help of the Figure 4(b) and (c) and the only dissimilarity in the production rate is in the rate of cooling during the compressor disk manufacturing process after the heat treatment of b homogenization (step I). Fig. 4(a) displays the microstructure view of a disk that is completely lamellar for comparison. It be supposed to be noted that the recrystallization time is not so important during step III to generate equiaxed and separated $\alpha_p$ grains ,as the grain growth in two phase of $\alpha$ and $\beta$ grains mixture is very sluggish[4][9].

In step IV, temperature is proved to be much more important in comparison to time because the temperature is driving factor of the solvus temperature of Ti2Al calculate whether or not Ti2Al particle age-hardening occurs in a system. For Ti-6141 (Ti2Al solvus approximately 645°C) and IMI 726 (Ti2Al solvus approximately 760°C), the required final treatment temperatures (590°C and 750°C in that order) would result in Ti3Al particle age-hardening. In addition, fine
less important a may be precipitate in the process during heat behavior in step IV, depending on the specifics of step III[10].

2.1.2. Fully lamellar microstructures:
A full lamellar microstructure is developed for some applications. The processing cycle has been described in fig. which is used to obtain these fully lamellar microstructures. In this step, a method is used to homogenization of the β grains in respective phase.

Given that there is no portioning effect for alloy have been presented in context of the fully developed lamellar layer, the extension with age hardening with the help of Ti2Al particle is typically superior than the bi-modal microstructure’s lamellar portion [7].

![Fig.6 Schematic diagram for processing for full lamellar microstructure](image)

3. RESULTS AND DISCUSSION
The one of the important micro structural constraint influential the properties for titanium alloy. With declining colony size (lessening slip distance end to end), ductility, yield stress, micro crack propagation resistance (determining the LCF strength jointly with crack nucleation resistance) are enhanced, while only a colony size is improved for macro crack propagation resistance including fracture toughness.

4. CONCLUSION
The size of lamellar of the colony type has been guided by rate of cooling in the region of the β phase and this derives from the size of grains of the β phase. Microstructure of the fully lamellar layers is bigger in size than the modal lamellar of β grains. This is the reason behind the small size of the particle at bi modal phase as per the cooling rate temperature variation. Furthermore, bi modal microstructures, the pessimistic consequence of permanent layer of the α and β layer limitations on property of the materials (mostly tensile ductility), which is relative to β-grains, is almost eliminate.

However, bi modal microstructure presents a type of alloy which exhibit the partitioning effect, and also diminishing the strength of grains under the pressure of the completely lamellar microstructure in the bi modal arrangement. This alloy material partition effect consequence in potency at room environment as opposed to the complete lamellar structure and lower creep confrontation of the bi modal structure. As the amount of the alloy constituent portioning effect increases with αp volume fraction, this volume fraction in bi-modal structures should be limited to about 15% volume, especially since the desired reduction in β grain size is already achieved with this low volume portion of αp. The results obtained on the Russian VT 25y alloy’s bi-modal microstructure indicate that it can be worth applying this bi lamellar principle to the lamellar regions of bi-modal structure.
5. REFERENCES


