Bulk Nanostructured Ti-alloys Showed Ultra High Strength

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KEYWORDS

Ti-alloys, nanostructured, high strength, low-cost

SHORT SUMMARY

New ultra-high strength Ti-alloys composing low-cost common metal (i.e., Mn) are presented here. In the present new alloys, the beta-phase was the predominant phase in the annealed condition and showed moderate tensile strength (UTS) in the range of 800-950 MPa where the fracture strain was below 4 %. After sever cold rolling followed by aging treatments, the UTS of the alloys were greatly increased and achieved values higher than 1900 MPa where the elongation was less than 1 %. The cold rolling process resulted in formation of nanoscale features such as nano-lamella and nano compositional modulation in the alloys. The ultra-high strength of the present new Ti-alloys make them competitive to high specific strength alloys because of its good cold workability and low-cost.

EXTENDED ABSTRACT

Metastable β-titanium alloys are found in many applications such as aircraft and automotive industries because of their highly attractive mechanical properties, such as high strength, low density, and high fracture toughness [1]. For example, the ultimate tensile strength (UTS) of the β -21S titanium alloy exceeds 1400 MPa along with good ductility[2]. Alloys designers have directed their efforts towards increasing the strength and/or decreasing the density of the materials used in manufacturing the automotive parts, in order to increase their specific strength. New alloys with higher specific strength are the candidate for future automotive industry as they show the greatest potential to reduce weight, save fuel, enhance performance of the future vehicle and therefore will lessen environmental impact.

It is desired to develop high strength β-type titanium alloys composing low-cost common metals such as Mn, Fe, Al or Sn so as to be applicable as high strength structural materials and at the same time for the biomedical applications [3, 4].

In this study, new ultra-high strength β-type Ti alloys composing of low-cost common metals (Mn) are developed.

The present new Ti-Mn alloys intrinsically show high strength besides its high affinity for work hardening by cold deformation. The strength of the alloys raised from ~900 MPa in the annealed condition to more than 1900 MPa after 90% cold rolling, as shown in **Figure 1**. Further improvement of the strength ductility trade-off can be dome through subsequent aging process, as shown in the same figure.

It is proposed here that the ultra-high strength achieved in these alloys are related to the nanostructure features appeared in the alloys after cold rolling, as shown in **Figure 2.** The nanoscale atomic modulation is systematically discussed in a recent publication [5]. The ultra-high strength of the present new β-type Ti-Mn alloys locate them as good candidates for the other high specific strength alloys because of their good cold workability and low-cost.

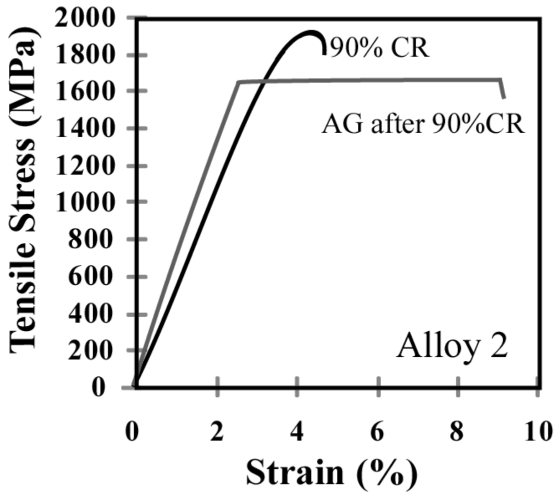

Figure 1 Tensile stress strain curves of Ti-14Mn Alloy after 90%cold rolling (CR) and subsequent aging at 873 K for 1.8 ks (AG).

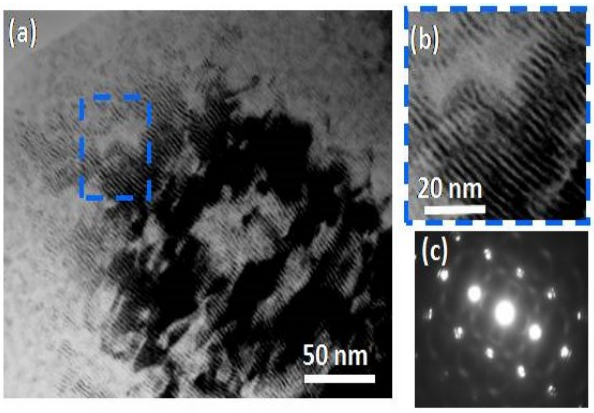

Figure 2 TEM bright filed image of Ti-14Mn alloy after 90%CR (a), the inset (b), and selected area diffraction pattern of [011]β zone axis.

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