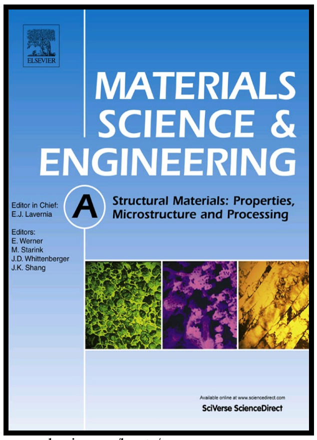

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S. Yang, X.C. Li, R. Wei, M. Meng, L. He, S.F. Zhang

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Deformation characteristic of a Ti-based bulk metallic glass composite with fine microstructure

S. Yang [a], X.C. Li [a], R. Wei [b], M. Meng [c], L. He [a,]*, S.F. Zhang [c,]*

[a] *State Key Laboratory for Mechanical Behavior of Materials, Xi'an Jiaotong University, Xi'an 710049, China*

[b] *School of Materials Science and Engineering, Zhengzhou University, Zhengzhou 450001, China*

[c] *State Key Laboratory of Military Stomatology, Department of Prosthodontics, School of Stomatology, Fourth Military Medical University, Xi'an, 710032, China*

* Corresponding author. Tel.: +86 29 82665165; fax: +86 29 826634533.

E-mail address: helin@mail.xjtu.edu.cn (L. He), sfzhang@fmmu.edu.cn (S.F. Zhang)

ABSTRACT

A bulk metallic glass composite (BMGC) with a composition of $Ti_{65.6}Cu_{13.2}Pd_{5.6}Sn_{3.6}Nb_{12}$ was prepared *via* suction casting. Microstructure mainly consisting of fine β-Ti dendrites sized about 5 μm and nano-scale interdendritic glassy matrix was obtained in the BMGC. The mechanical behavior was compared with that of the same alloy in a polycrystalline state under compressive and bending conditions. It was found that the nano-scale glassy matrix with limited volume fraction remarkably increased the yield strength of the BMGC, furthermore, plastic deformability of the corresponding polycrystalline alloy could be preserve by the BMGC. Upon loading, the nano-scale glassy matrix could exert a strong restriction effect on the slip deformation inside the micron-scale dendritic crystals; no obvious shear-banding was exhibited in the glassy matrix during the deformation. This deformation characteristic might be attributed to the possible homogeneous deformation mode of the glassy matrix at the nano-scale.

Keyword: Mechanical characterization; Bulk metallic glass composite; Titanium alloys; Grains and interfaces; Plasticity

1. Introduction

Ti-based bulk metallic glasses (BMGs) free of toxic and harmful elements are considered as potential biomedical materials for load-bearing application owing to their higher elastic limit, lower Young's modulus, and better biocompatibility [1-3]. Like most other BMGs, however, Ti-based BMGs suffer from room-temperature brittleness [4]. To enhance the ductility, a microstructural design strategy to produce *in-situ* Ti-based BMG composites (BMGCs) consisting of β-Ti dendrites and a glassy matrix has been successful [5]. However, the microstructural design strategy was applied mostly in Ti-based BMGC alloys containing toxic element Be [5-10].

According to the research work on Be-containing Ti-based alloys, mechanical behavior of *in-situ* dendrite-reinforced BMGCs depended on proper design and control of their microstructure [5]. To facilitate primary precipitation of dendrites, addition of a β-isomorphous element with higher melting point (such as V, Nb or Ta) was necessary in the alloys [5,7-10]. Furthermore, it was expected that the size of dendrites was one of the key factors affecting the mechanical properties. Microstructure with coarse dendrites was beneficial to the interaction between dislocation-based deformation within the dendritic phase and shear-banding within the glassy matrix, which could effectively enhance the ductility of the BMGCs [5,11-13]. In order to obtain the desirable microstructure, a semi-solid processing method was recommended to prepare the *in-situ* dendrite-reinforced BMGCs [11]. By heating and isothermal holding BMGC alloys in the semi-solid temperature regions, dendrites could precipitate and growth under a "near-equilibrium" condition, the microstructure with coarse dendrites