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Analysis of Gum Metal crystallographic texture and misorientation in correlation to its mechanical behavior

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Recently, a class of metastable β-Ti alloys called Gum Metal has been drawing attention due to its unique mechanical performance and the related microstructural features as well as unconventional deformation mechanisms [1-3]. This work discusses the correlation between texture and crystallographic misorientation of Gum Metal and its mechanical behaviour.

In this work, a Gum Metal rod with composition Ti–36Nb–2Ta–3Zr–0.3O (in mass %) was supplied by Fukuoka University. The fabrication route included billet forming from mixed powders, sintering, hot forging and cold swaging with 90% reduction in area, as described in [4].

The electron backscatter diffraction (EBSD) was conducted on a JEOL JSM-6480 scanning electron microscope (SEM) at the acceleration voltage of 20 kV. EBSD orientation maps of a transverse cross-section of Gum Metal samples are shown in Figs. 1 a and 1 b. Elongated grains with fiber-like structures and near random orientations can be noticed. The misorientation profile analyzed across line A–A, passing along two grains, is presented in Fig. 1c. There is a change in orientation up to 14° and up to 9° within the elongated area of the first and the second grains, respectively. The pole figures, shown in Fig. 2a, indicate a pronounced fiber <110> texture along the cold swaging axis of Gum Metal. The characteristics observed via EBSD are results of cold working applied to Gum Metal during its fabrication.

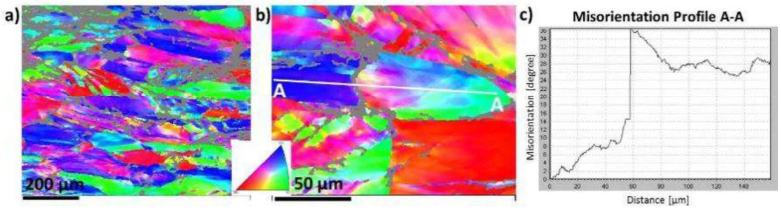

Fig. 1: EBSD orientation maps of grain orientations of Gum Metal transverse cross-section with scales (a) 200 μm and (b) 50 μm and (c) misorientation profile obtained along line A-A.

Elastic constants of Gum Metal were determined based on measurements of ultrasonic velocities using a pulse-echo method. The polycrystalline rod of the alloy, analysed in this study, exhibited a transversal isotropy around its longitudinal axis, which was confirmed by EBSD and ultrasonic measurement. Different values of Young's moduli measured in two perpendicular directions, shown in Fig. 2b, indicate considerable elastic anisotropy of Gum Metal related to its strong axial texture presented in Fig. 2a.

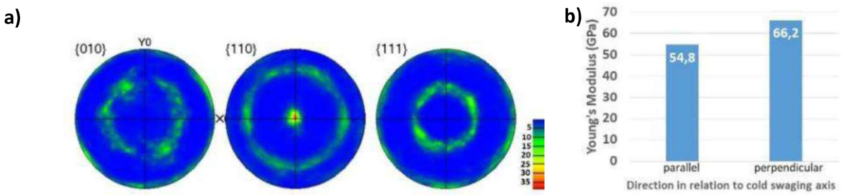

Fig. 2: a) Pole figures of Gum Metal; b) Young's modulus dependence in relation to cold swaging direction.

In conclusion, the results of ESBD characterization and ultrasonic measurements of metastable β-Ti Gum Metal were presented. The correlation between strong texture of the alloy induced during its fabrication and the elastic anisotropy was shown.

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