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THERMOMECHANICAL BEHAVIOR OF GUM METAL UNDER CYCLIC COMPRESSION

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Gum Metal (Ti–36Nb–2Ta–3Zr–0.3O in mass%) is a beta titanium alloy developed at Toyota Central R&D Labs., Inc. with exceptional properties, i.e. low elastic modulus, high strength, nonlinear superelastic-like deformation [1]. Recent studies confirmed that this set of unconventional properties occurs mainly due to activity of two microstructural features martensite-like nanodomains and ω phase precipitates. This work aims at application of the technique of infrared thermography to register thermomechanical nature of the unconventional deformation mechanisms activated in Gum Metal under compression [2, 3].
To this end, cube samples were machined out of a Gum Metal rod, texturized along <110> direction. They were subjected to cyclic compression with an two strain step on a testing machine. The deformation was simultaneously monitored by a visible range and an infrared cameras for determining strain changes and thermal response of the alloy, respectively. Stress-strain curves confirmed the superelastic-like deformation and high plastic performance of Gum Metal. The changes of the temperature rate precisely indicated subsequent stages of Gum Metal deformation especially during the large superelastic-like deformation. In this regime, significant changes in the growth rate of the thermal response were observed. As in conventional materials, the first stage of compression is a linear, fully elastic deformation accompanied by a temperature growth. The second stage is a nonlinear deformation which is reflected by change of the temperature growth rate. The change can be associated with martensite-like nanodomains activated during the compression of Gum Metal. Further high plastic deformation without hardening was accompanied by a rapid growth in temperature. The thermal response of the alloy under compression, determined within the large recoverable strain, gave an insight into the nature of the deformation mechanisms of Gum Metal.

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