Supplementary Materials: Microstructure Evolution by Thermomechanical Processing in the Fe-10Al-12V Superalloy

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S1. Modeling Cooling Rates on Air Convection

The estimation of the cooling rates during air cooling (natural convection) on the carbide conditioning treatments is presented. Two sample geometries were considered according to the experimental tests. Sample A (parallelepiped): 12 × 12 × 30 mm and Sample B (Cylinder): ∅50 × 40 mm. The modeling of the cooling temperature will only assume convective heat extraction through the surfaces. We only focus on the point of the sample where the cooling rate is lowest (barycenter in the case of the cylinder, sample B). The parallelepiped (sample A) was air-cooled with one of its faces on a refractory material. Therefore, the cooling of this surface can be neglected. For this sample, the center of this face will be the point with the slowest cooling rate. To simplify the modeling of this asymmetric condition, it is possible to consider equivalently a sample of twice the height where the heat extraction is performed on all surfaces. On this simplification, the thermal evolution on the barycenter of this new parallelepiped is calculated.

The thermal models and tables for solving the unsteady-state cooling problem for the different sample geometries were extracted from Chapter 4 of Ref. [25]. The parameters used for the calculation were: material density ρ = 7844 kg m^{-3}, constants thermal conductivity (κ = 37.9 Wm^{-1}K^{-1}) and specific heat ($\mathbb{C}$ = 656.4 J kg^{-1}K^{-1}) obtained from averaging the values between 300 °C and 700 °C for a 1045 steel [26] and a convective heat transfer coefficient of h = 70 Wm^{-2}K^{-1} for air natural convection of a steel surface [27]. It is known that the heat transfer coefficient could be modified by the surface roughness [28], and as Sample B was used as-cast (high surface roughness) we increase h by a factor of 1.3 for Sample B ($h_{(B)}$ = 91 Wm^{-2}K^{-1}). Fig. S1 shows the estimation of temperatures during the process of air cooling for two types of samples used in the present work.

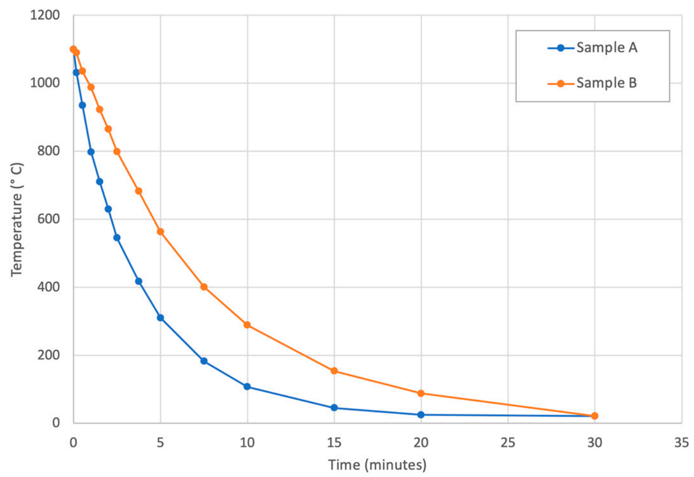

Figure S1. Estimation of air-cooling rates (natural convection) of samples.

S2. Compression Tests

Figure S2 shows the strain curves at 900 °C for different compression strain rates in the Fe-12Al-12V (%at.) alloy, from Ref. [24]. The shape of the curve for the strain rate of 1 s^{-1} indicates a continuous dynamic recovery mechanism and for higher values of strain rate, the curves present multiple peaks of hardening and softening which is typical of a discontinuous dynamic recrystallization mechanism.

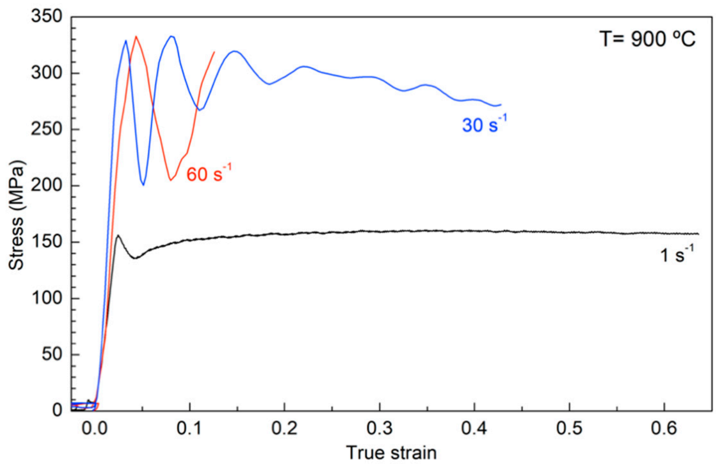

Figure S2. Uniaxial compressive test at 900 °C for different strain rates in the Fe-12Al-12V (%at.) alloy. Adapted from Ref. [24].

Experimental Methods Ref. [24].

The specimens were obtained by EDM in dimensions of Ø10 × 15 mm in a Fe-12Al-12V (%at.) alloy. Compressive tests at 900 °C under vacuum were conducted on a Gleeble-3500 thermal simulation machine.