Effect of Hot Deformation on Microstructure and Precipitation Kinetics in M789 Cobalt-Free Maraging Steel Produced by SLM

Dr Mariusz Król, Silesian University of Technology, Gliwice, Poland
Dr Wojciech Borek, Silesian University of Technology, Gliwice, Poland
Dr Błażej Tomiczek, Silesian University of Technology, Gliwice, Poland
Dr Przemysław Snopiński, Silesian University of Technology, Gliwice, Poland

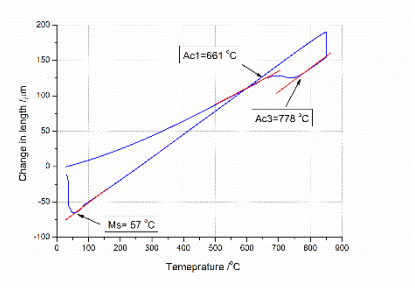
Abstract

Statement of the problem: The presented work aims to evaluate the effect of hot deformation on microstructure, martensitic transformation kinetics and precipitation behaviour in an additively manufactured M789 cobalt-free maraging steel. The steel samples produced by the SLM method were subjected to deformation using the Gleeble 3800 thermomechanical simulator in temperature 900 and 1100 °C with true strain 0.15 and 0.30. The hot deformation temperature range was established according to dilatometry analysis, where phase transition temperatures were determined based on inflections from tangents to the curve. Afterwards, a series of heat treatment operations were conducted using a BAHR dilatometer 805A/D. The findings demonstrated that the deformation favoured the refinement of martensitic lathes and blocks in a form proportionate to the reduction in sample dimension and a preferred alignment towards the centre of the sample. The flow stress of the additive manufactured M789 maraging steel decreased with increasing temperature. With increasing deformation temperature, the grain size increases, accompanied by an increase in the width of the martensite laths. Deformation increased the kinetics of precipitation and reverted austenite formation during the ageing process. Cylindrical samples ϕ10x15mm produced by the SLM method were preliminarily subjected to hot deformation using the Gleeble 3800 thermo-mechanical simulator at 900 and 1100°C. The samples were heated at a heating rate of 3°C/s, and then isothermal heating at this temperature for 300s then subsequent samples were deformed with true strain values 0.15 and 0.30 with a strain rate $0.1s^{-1}$ and cooled to room.

Conclusion & significance: Based on the dilatometric curve in Fig. 1, the austenite reversion start (Ac1) and finish (Ac3) temperatures were determined as 540 °C and 720 °C, respectively; meanwhile, the martensite start (Ms) temperature was approx. 50 °C.

Image

a)



b)

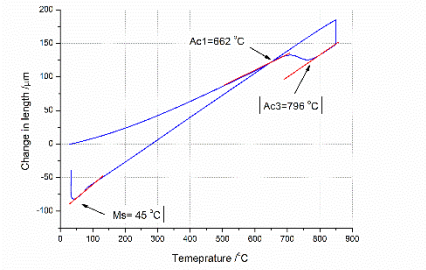


Figure 1. Dilatometric curve of deformed samples: a) SLM part, b) true strain 0.3 at 1100 □C

Recent Publications

1. Król M., Snopiński P., Hajnyš J., Pagáč M., Łukowiec D. Selective Laser Melting of 18NI-300 Maraging Steel. Materials. 2020; 13(19):4268. https://doi.org/10.3390/ma13194268
2. Tomiczek B., Snopiński P., Borek W., Król M., Gutiérrez AR., Matula G. Hot Deformation Behaviour of Additively Manufactured 18Ni-300 Maraging Steel. Materials. 2023;16(6):2412. https://doi.org/10.3390/ma16062412
3. Król M., Snopiński P., Pagáč M., Hajnyš J., Petrů J. Hot Deformation Treatment of Grain-Modified Mg–Li Alloy. Materials. 2020; 13(20):4557. https://doi.org/10.3390/ma13204557
4. Brytan Z., Król M., Benedyk M., Pakieła W., Tański T., Dagnaw MJ., Snopiński P., Pagáč M., Czech A. Microstructural and Mechanical Properties of Novel Co-Free Maraging Steel M789 Prepared by Additive Manufacturing. Materials. 2022; 15(5):1734. https://doi.org/10.3390/ma15051734

Photograph

Biography

Mariusz Król's research encompasses a wide range of topics within materials engineering, with a particular focus on the properties, mechanical testing, and applications of materials. He has conducted extensive studies on the structure and properties of various light alloys and thermal analysis, demonstrating a remarkable interest in advancing the understanding and application of these fields.

Email: mariusz.krol@polsl.pl