Enabling Multi-Functional Performance through Multi-Material Additive Manufacturing

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Novel high-strength processing optimized Al-Mg-Zn-Cu-Ag alloy wire for Demonstrator 2 developed by LKR

The aviation application targeted by demonstrator 2 requires the use of a high-strength alloy wire. The commercial unavailability of such wires is due to their poor processability in fusion welding technologies in contrast to friction stir welding. Such high-strength aluminium alloys based on the Al-Zn-Mg-Cu are commonly referred to as unweldable or at least very challenging to process.

Thus, the alloying concept was adapted to offer a more robust processing window for wire-arc additive manufacturing being closely related to fusion welding, while maintaining the high mechanical property portfolio. For this purpose, the Mg/Zn ratio was varied to omit the formation of hot cracking. On top of that this variation changes the precipitation behaviour from η-phase formation to T-phase formation resulting in a substantially reduced quench rate sensitivity of the novel alloy system [1]. The microstructure following artificial aging is shown in Figure 1.

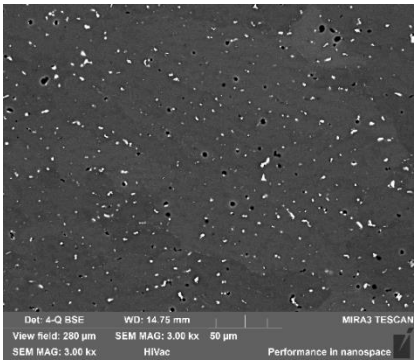

Figure 1. Microstructure of the newly developed Al-Mg-Zn-Cu-Ag alloy following an artificial age-hardening treatment.

Further the mechanical properties were increased using Ag microalloying additions resulting in a refinement of the precipitate structure. The resultant proof strength is above 400 MPa as tested in both longitudinal and transversal directions.

Current works focus on the upscaling of the wire manufacturing route to provide sufficient alloy wire for the fabrication of demonstrator 2 at LORTEK and on the provision of more detailed characterization results performed in collaboration with DLR and ISQ.

[1] G. Graf, P. Spoerk-Erdely, P. Staron, A. Stark, F. Mendez Martin, H. Clemens, T. Klein, Quench rate sensitivity of age-hardenable Al-Zn-Mg-Cu alloys with respect to the Zn/Mg ratio: An in situ SAXS and HEXRD study, Acta Mater. 227 (2022), 117727.

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