Transfer of the AA6013-T4 aircraft alloy to automotive applications

Some of AMAG's R&D activities are intended to accelerate the transfer of well-established, high-strength aerospace materials into other areas of lightweight design such as automotive applications. In general, this requires various modifications to the materials and the related production processes, in order to accommodate higher volume demands and stringent cost considerations. The high-strength 6xxx-alloy AA6013 is one such example, AMAG offering its newly developed heat treatment process to improve the material's mechanical properties even further while reducing the heat treatment cycle times after sheet forming required at the customer's plant.

Previous publications have demonstrated that during the standard T6-heat treatment of other 6xxx-alloys, a delay time between solutionizing and artificial ageing of over 90 minutes results in a dramatic reduction in mechanical properties due to natural ageing [1, 2].

However, it has also been shown that a suitable pre-aging procedure immediately after solution heat treatment effectively reduces the detrimental effects of natural ageing on the artificial ageing kinetics and can lead to a strength increase of up to 20 per cent as compared to standard material. The resultant highly formable T4* temper only requires very short heat treatment in order to reach peak strength.

In particular, the AA6013 alloy differs from the 6061 or 6082 alloys due to its copper content, which contributes to the strength increase. In Fig. 1, the evolution of the mechanical properties of AA6013 in dependence upon the starting temper T4 and T4* is shown as a function of artificial ageing time at 205°C. AMAG's pre-ageing treatment after the solutionizing of AA6013 leads to higher ultimate tensile strength (UTS) (Fig.1) and elongation A_{50} (Fig. 2) at a constantly high yield strength (YST) level in the artificially aged temper T6. These improved material properties make the alloy ideal for applications in the automotive industry, where high strength and elongation are required e.g. for energy absorbing components.

The required minimum mechanical properties in temper T6 can be fulfilled with AA6013 T4* by artificial aging with the typical automotive heat treatment cycle for copper containing 6xxx-alloys of 60min at 205°C instead of the AA6013 standard ageing treatment of 4 hours at 190°C. This fast ageing response therefore reduces heat treatment cost of fabricated parts and provides energy savings.

In addition, the properties in the artificially aged T6 temper indicate better formability. This enables the forming of less complex parts in T6 temper instead of forming in T4 with subsequent artificial ageing of the component. ■

Conclusions:

By means of controlled copper and manganese levels, the AA6013 alloy provides higher strength levels than the Al-Mg-Si alloys used at present in the automotive industry, while retaining good corrosion resistance and formability. This controlled copper content is coupled with a fine grain structure that responds well to forming [3]. AMAG can manufacture AA6013 T4* sheet in serial production using an additional heat treatment unit that has already been integrated into the processing line.

References

[1]. C. Zelger, J. Schnitzlbaumer, R. Prillhofer, J. Enser, C. Melzer: „Optimized Heat treatment sequences for AA6061", Supplemental Proceedings, Volume 1, Materials Processing and Properties, TMS (The Minerals, Metals & Materials Society), 2010.
[2]. C. Zelger, P. Oberhauser, C. Melzer, P. Schulz: „Advanced 6xxx alloys for electronic applications", Proceedings of EMC 2009, pp. 1419-1425, 2009.
[3]. J. Berneder, R. Prillhofer, J. Enser, P. Schulz, C. Melzer: "Study of the Artificial Aging Kinetics of different AA6013 heat treatment conditions", Proceedings TMS 2011, San Diego, USA.

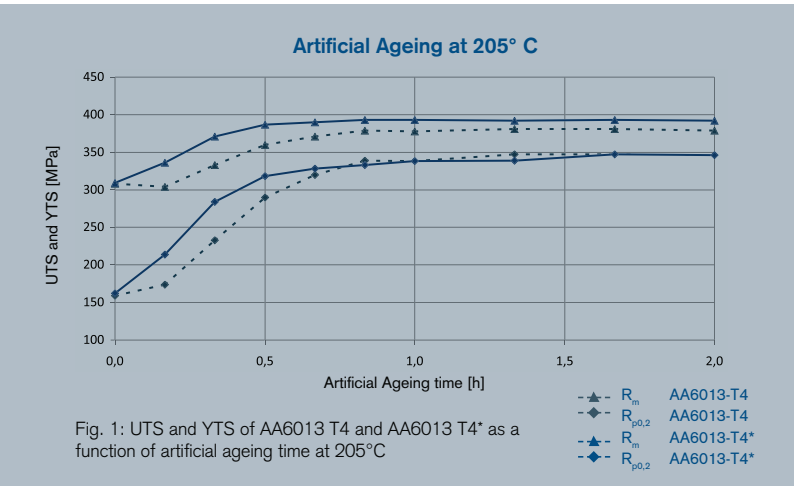

Fig. 1: UTS and YTS of AA6013 T4 and AA6013 T4* as a function of artificial ageing time at 205°C

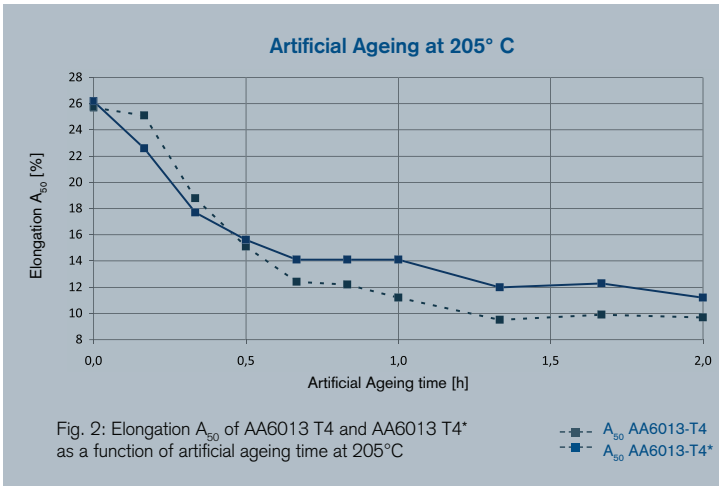

Fig. 2: Elongation A_{50} of AA6013 T4 and AA6013 T4* as a function of artificial ageing time at 205°C