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EFFECT OF PRIOR CREEP ON TENSILE PROPERTIES OF AA2124/SiC COMPOSITES

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1. Introduction

Tensile tests after prior creep were performed on low-alloy C–Mn, 3Cr–Mo steels [1] and Inconel X-750 [2] exhibiting their good mechanical behaviour. Also, metal matrix composites (MMCs) are known for their superior tensile strength and creep resistance compared to aluminum alloys, thanks to ceramic reinforcements.

The aim of this research, was to check how the tensile properties of the AA2124/SiC composites may change after prior creep and whether the results are comparable to those achieved for already tested materials.

2. Materials and methodology

Metal matrix composites (MMC) with AA2124 aluminum alloy as a matrix and SiC reinforcement of different grain size equal to 3μm and 0.6 μm and amount equal to 17 vol % and 25 vol % were investigated. A series of strain-controlled tensile tests were carried out at the strain rate equal to 0.0002 s^{-1} on the MTS 858 servo-hydraulic testing machine at ambient temperature [3]. Tensile tests were performed on both MMC types in the as-received state and the same materials subjected to prior creep. Creep tests were conducted at 300ºC and interrupted at a given value of strain, and subsequently, the specimens were subjected to the standard tensile examinations.

3. Results

As it was expected, the tensile curves for specimens after creep were characterized by a weaker stress response in comparison to those tested in the as-received state, Figs. 1-3. Moreover, the specimens after creep exhibited in most cases a higher strain at rapture in comparison to those tested in the as-received state. It has to be emphasized that the tensile curves for specimens made of the AA2124/SiC with the same content of SiC and the same particle size are similar to each other regardless of the creep stress applied previously to the specimens and value of strain at which the creep tests were interrupted. They differ in time to rapture, only.

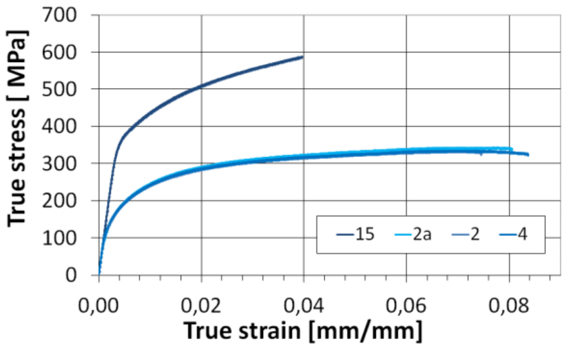

Fig. 1 Comparison of tensile curves for composite AA2124+17%SiC (3 μm) in the as-received state and after creep: specimen 15 represents material in the as-received state, specimens 2, 2a and 4 the same material after creep

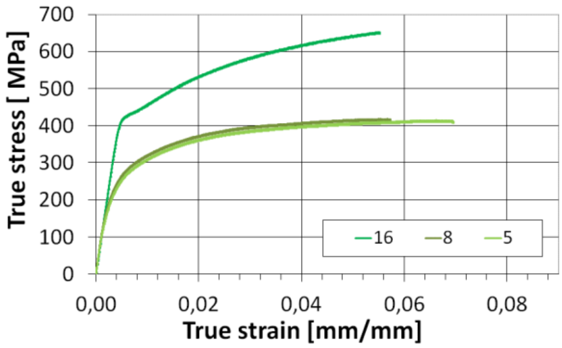

Fig. 2 Comparison of tensile curves for composite AA2124+17%SiC (0.6 μm) in the as-received state and after creep: specimen 16 represents material in the as-received state, specimens 5 and 8 the same material after creep

The lowest stress response was noticed for the AA2124+17%SiC (3 μm) with the lower SiC content and its coarser grain size, Fig. 1 and Fig. 4. The highest stress response was observed for the AA2124+25%SiC (0.6 μm) with the higher SiC content and its finer grain size, Fig. 3 and Fig. 4. On the other hand, strain values at rupture were the largest for the AA2124+17%SiC (3 μm) and the smallest for the AA2124+25%SiC (0.6 μm).

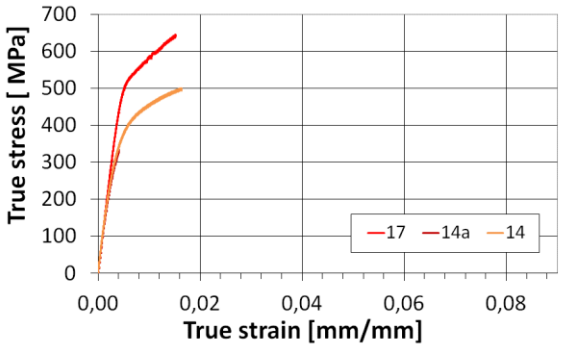

Fig. 3 Comparison of tensile curves for composites AA2124+25%SiC (0.6 μm) in the as-received state and after creep: specimen 17 represents material in the as-received state, specimens 14a and 14 the same material after creep

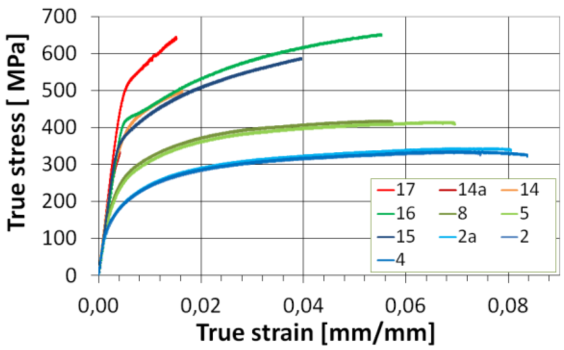

Fig. 4 Comparison of tensile curves for all composites tested in the as-received state and after creep

Based on the tensile characteristics for the materials in as-received state and after creep deformation, the elastic modulus and yield points were determined, Tables 1-2.

Table 1. Elastic modulus for the specimens in as-received state and after creep

Material	As-received [GPa]	After creep [GPa]
17% SiC, 3 μm	101	103
17% SiC, 0.6 μm	95	100
25% SiC, 0.6 μm	112	116

One can easily notice slight differences in values of the elastic modulus for the material in as-received state and after creep, Table 1. Slightly smaller values were obtained for specimens in the as-received state.

Table 2. Yield point at 0.2% offset strain for the specimens in as-received state and after creep

Material	As-received [MPa]	After creep [MPa]
17% SiC, 3 μm	383	174
17% SiC, 0.6 μm	436	247
25% SiC, 0.6 μm	528	382

Yield point values determined for the offset strain equal to 0.2% were 2.2, 1.8 and 1.4 times greater for the specimens in as-received state than those after creep for the AA2124+17%SiC (3 μm), AA2124+17%SiC (0.6 μm), AA2124+25%SiC (0.6 μm), respectively, Table 2.

4. Conclusions

The highest values of stress and the smallest strain at rapture were observed for the AA2124+25%SiC (0.6 μm). An opposite response was achieved for the AA2124+17%SiC (3 μm). Moreover, the tensile curves obtained for the specimens made of the same material, but with a different creep history, were similar to each other. Elastic modulus was slightly lower for the specimens tested in as-received state in comparison to those after creep. In the case of yield point values their variations were more significant depending on the material condition. Much greater values were obtained for the specimens in as-received state in comparison to those determined for the specimens subjected to prior creep.

Acknowledgements

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