AlMg/SiC METAL MATRIX COMPOSITE UNDER FATIGUE AND CREEP CONDITIONS

***A. Rutecka*[1], *Z. L. Kowalewski*[1, 2], *K. Pietrzak*[2], *L. Dietrich*[1], *K. Makowska*[2], *J. Woźniak*[3], *M. Kostecki*[3], *W. Bochniak*[4] *and A. Olszyna*[3]**

[1] *Institute of Fundamental Technological Research, Warsaw, Poland*
[2] *Motor Transport Institute, Warsaw, Poland*
[3] *Warsaw University of Technology, Faculty of Materials Science and Engineering, Warsaw, Poland*
[4]*AGH University of Science and Technology, Faculty of Non-Ferrous Metals, Cracow, Poland*

1. Introduction

Metal matrix composites (MMCs) belong to ceramic reinforced materials that mechanical properties should be enhanced in comparison to the matrix [1, 2]. Moreover, the composites are to be used in aerospace and automotive industries where light and simultaneously durable materials are required. One of the advantages of MMCs is that they can be produced using methods similar to those used for the monolithic materials. Hence, the KoBo method was used to manufacture AlMg/SiC MMCs [3]. Mechanical tests and microstructural observations were carried out to investigate damage process under fatigue and creep conditions [4].

2. Materials

The Al7,9Mg powder of 99,7% purity and the SiC powder of 99,8% purity were used during MMCs production; an average particle size were equal to 14,6 μm and 0,42 μm, respectively. Powders were blended, pressed and extruded in the form of rods using the KoBo 100T horizontal hydraulic press. The SiC content was equal to 0; 2,5; 5; 7,5 and 10%.

3. Details of experimental procedure

Fatigue tension-compression tests were performed under stress control at ambient temperature. Stress amplitudes were equal to 220 and 240 MPa. Sine shape cycles (R=-1) were applied with the frequency of 20 Hz. Hysteresis loops during subsequent cycles were captured.

Step increasing tensile creep tests were carried out at 200°C. Three levels of stress equal to 40, 60 and 70 MPa were applied. Creep curves were elaborated.

Microstructural observations using optical light microscopy and scanning electron microscopy were performed before and after fatigue and creep tests. An influence of reinforcement content as well as an influence of fatigue and creep processes on material degradation were analyzed.

4. Synthesis of experimental results obtained

Representative fatigue and creep results in a form of the hysteresis loops and creep curves, respectively, are presented in Figs 1 and 2. Microscopic patterns of fracture surfaces are also shown in these figures. Cyclic softening followed by decreasing of inelastic strain amplitude were observed during subsequent cycles. The effect was indentified for higher stress amplitude (240 MPa). Moreover, it was stronger for lower content of SiC particles. In most cases, higher SiC content resulted in lower cyclic softening. Unfortunately, shorter lifetimes with increasing SiC content were obtained. Creep parameters become more favorable if the SiC content did not exceed 5%. Above this value they decreased. It is worth to notice that creep resistance was higher for reinforced materials in comparison to the matrix.

Microstructural observations showed existence of discontinuities before and after mechanical tests. The volumetric fraction of defects increased with an increase of reinforcement content.

a) b)

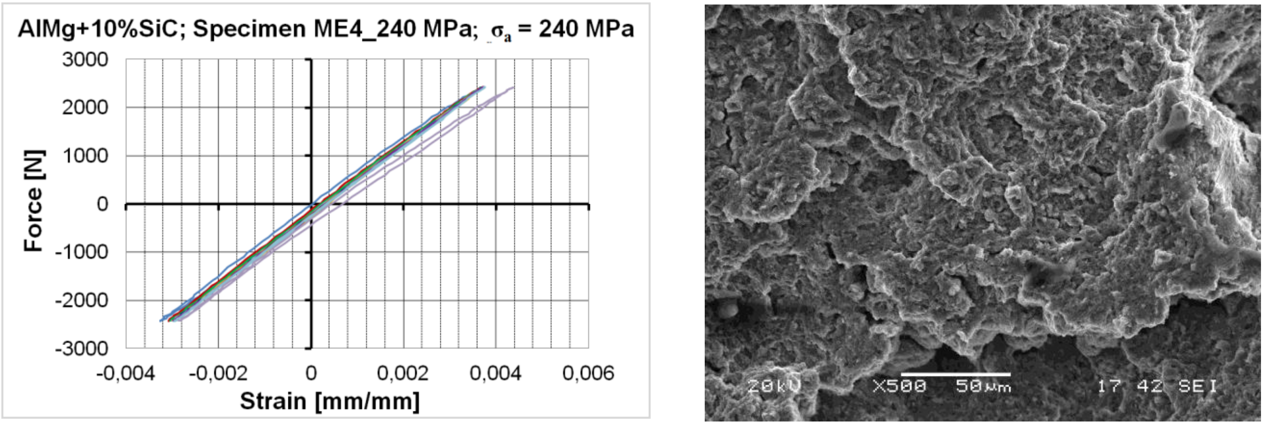

Fig. 1. AlMg+10%SiC: (a) fatigue test results in the form of hysteresis loops after 100 cycles; (b) fracture surface (SEM, magn. x500)

a) b)

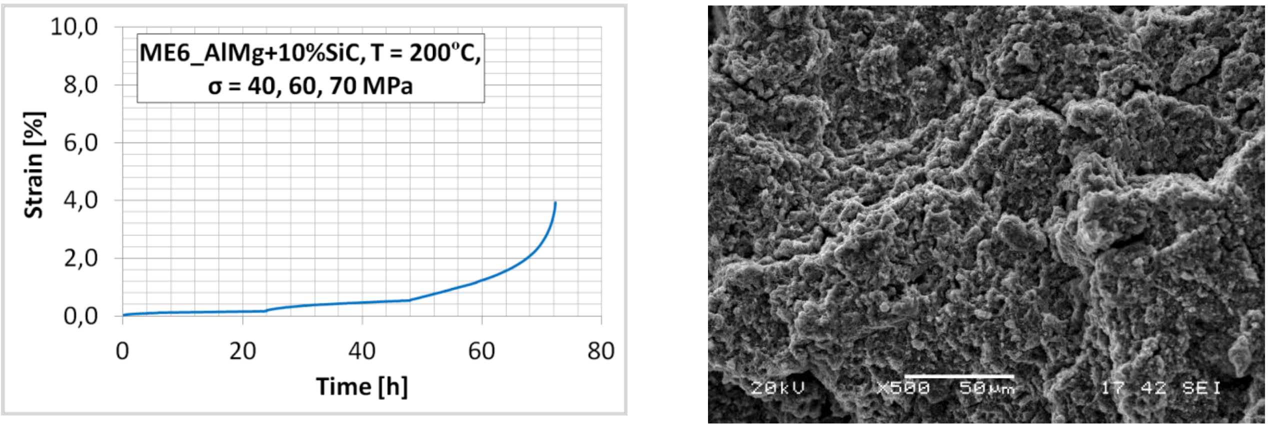

Fig. 2. AlMg+10%SiC: (a) creep test results in the form of creep curve; (b) fracture surface (SEM, magn. x500)

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6. References

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