STRAIN RATE SENSITIVITY ASSESSMENTS OF AN A359 ALUMINIUM ALLOY MATRIX AND A359/SIC$_P$ METAL MATRIX COMPOSITE UNDER COMPRESSION

Wojciech MOĆKO[(a)], Adam KLASIK[(a)], Zbigniew L. KOWALEWSKI [(a, b)]
(a) Motor Transport Insitute, ul. Jagiellońska 80, 03-301 Warsaw, Poland
(b) Institute of Fundamental Technological Research, ul. Pawińskiego 5B, 02-106 Warsaw, Poland

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1- **Introduction**

Metal matrix composites (MMC) based on aluminum alloy are used in many branches of the industry: aerospace, military techniques and civil engineering or transport. One of the latest applications of this type of materials is breaking discs for vehicles. Since a wide knowledge concerning mechanical properties of composites in static and dynamic regime of work is needed in order to design and make high quality product, further experimental investigations should be carried out.

Two materials were investigated in this study: the A359 aluminum alloy fabricated by the Polish Enterprise „BOBREK" and the F3S.X0S metal matrix composites reinforced by 10%, 20% and 30% of SiC particles made by Duralcan company. The length and diameter of the manufactured specimens were the same and equal to 5 mm which gives aspect ratio 1:1. The same geometry of specimens was used in static and dynamic compression tests.

Compression tests for static and quasi-static strain rates were carried out using the Instron servo-hydraulic testing machine. The strain was measured by means of the typical mechanical extensometer. The Split Hopkinson Pressure Bar (SPBH) method was applied for material testing under high strain rates. The incident and transmitted bars of 20 mm diameter and 1000 mm of length were made of the high quality maraging steel. The strain gauges were placed in the middle of each of these bars. Incident and transmitted waves were amplified and recorded with the use of Agilent digital oscilloscope. Double wave analyze were used to compute stress-strain curves on the basis of strain gauge signals. All tests were carried out at room temperature. The range of strain rates was chosen to be within limits from 10^{-4} s^{-1} to $3{,}5x10^{-3}$ s^{-1}.

2 – **Experimental results**

The results of compression tests at strain rate of 10^{-2} s^{-1} for the F3S.X0S metal matrix composite and the A359 aluminum alloy are shown in Fig.1. The stress-strain characteristic of the F3S.X0S is significantly stronger (about 100 MPa) in the plastic region than that for the aluminum alloy without reinforcement obtained. Stress-strain curves for the F3S.10S, F3S.20S and F3S.30S MMC's are very similar what means that the applied amount of the SiC reinforcement only slightly changes the typical stress parameters (e.g. yield point) of the A359/SiC$_p$ composite. The strain hardening effect was observed under static and quasi-static conditions for both types of materials.

A comparison of the stress-strain curves for the A359 aluminum alloy and F3S.X0S metal matrix composite are presented in Fig. 2. They were obtained under different strain rates in the static and dynamic ranges. As it is clearly seen, in both cases the characteristics are almost independent on strain rate magnitude. An opposite effect was observed by Li et. al [1] who also tested the MMC's, however, for the strain rates higher than 10^5 s^{-1}. The stress-strain curves of the F3S.X0S for dynamic conditions do not exhibit hardening effect above the deformation level equal to 0.1. Therefore, it can be concluded that the strain hardening is balanced by thermal softening due to an adiabatic heating [2].

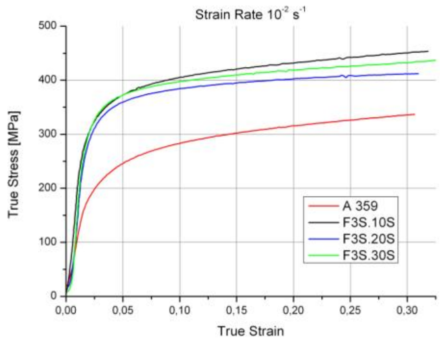
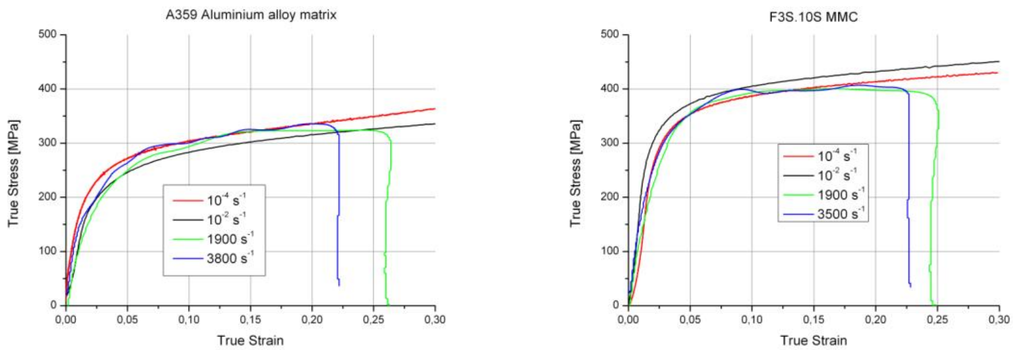


Figure 1: Stress-strain curves of the A359 aluminum alloy matrix and F3S.10S metal matrix composite determined for the strain rate of 10^{-2} s^{-1}



a) b)

Fgure 2: Stress-strain curves of: (a) A359 aluminum alloy matrix; (b) F3S.10S metal matrix composite determined for selected strain rates

3 – **Conclusions**

The SiC reinforcement of the aluminum alloy tested increased significantly the flow stress magnitude. Independently on the reinforcement degree (10% to 30%) the hardening effect was similar for all MMC materials taken into considerations and it was about 100 MPa higher than that for the aluminum alloy achieved. There was no clearly visible strain rate sensitivity for tested materials within the range of strain rates. For higher strain rates the MMC does not show the strain hardening effect above the strain level of 0.1 due to the thermal softening.

4 – **References**

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