PAPER REF: 4757 *(Invited Paper)*

AN EFFECT OF NON-HOMOGENEOUS FIBRE PACKING ON MECHANICAL PROPERTIES OF OXIDE/NICKEL COMPOSITES

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ABSTRACT

This work generalises results obtained by the authors studying room temperature strength and creep of oxide-fibre/nickel-based-matrix composites. An effect of fibre packing in the cross-section of a composite body together with that of fibre/matrix interface strength on mechanical behaviour is analysed. It is shown that if the interface strength does not depend of fibre volume fraction, then the strongly non-homogeneous fibre packing will not yield a decrease in the creep resistance.

Keywords: metal matrix composites, oxide fibre, nickel matrix, fibre packing, creep.

INTRODUCTION

A homogeneous fibres packing in the metal-matrix composite body is normally a wanted reinforcement scheme. Optimization of a structural element will often require a special fibre packing. On the other hand, a non-homogeneous fibre distribution is often observed in specimens made to evaluate mechanical properties of the composite. Therefore, understanding an effect of non- homogeneity of the fibre packing on mechanical response of composites is an important problem of composite mechanics. The problem is complicated as various properties depend on a degree of the non- homogeneity in different ways. The composite strength at high fibre volume fractions is normally higher when the fibre packing is more homogeneous [Mileiko, 1997]. In the case of creep, the situation is not so simple, so in the present paper the authors consider mainly the creep behavior of metal-matrix composites.

RESULTS AND CONCLUSIONS

Experiments were carried out on composites with four types of oxide fibres produced by the internal crystallization method [Mileiko, 2005 and two nickel as the matrix. A dependence of creep resistance on fibre volume fraction for one composition is given in Fig. 1. This is a typical dependence: the scatter of experimental date is very large, the creep resistance reaches a maximum at some value of the fibre volume fraction. To interpret the experimental data, the following consideration should be taken into account:

1. The fibre/matrix interface strength, which is an important parameter determining creep resistance, can be constant up to a definite value of fibre volume fraction V_f and then goes down. This effect was found in experiments with specimens with sufficiently homogeneous fibre packing [Mileiko et al., 2002].
2. This effect can influence local areas of the specimen cross-section with high fibre concentration forming fibre clusters with low interface strength.
3. In power function $\dot{\varepsilon} = \eta \left(\sigma / \sigma_n\right)^n$ describing the dependence of creep rate ε̇ on stress, constants σ_n и n depend on fibre volume fraction [Mileiko, 2002].

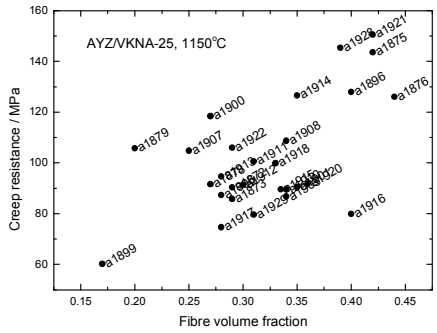

Fig. 1 - Creep resistance of the Al_2O_3-$Y_3Al_5O_{12}$-ZrO_2-eutectic-fibre/VKNA25-matrix composites versus fibre volume fraction.

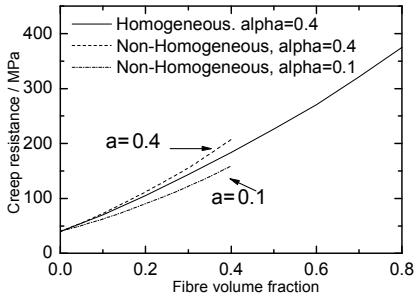

Fig. 2 - Dependencies of creep resistance of composite models with homogeneous and non-homogeneous fibre packing on average fibre volume fraction for relatively strong interface (α = 0.4). The same dependence for a model with weak interface (α = 0.1) and non-homogeneous fibre packing.

These experimental observations allow calculating creep resistance of composites with non-homogeneous fibre packing. In the full-text paper a simple model example is considered to compare creep resistance of two composite specimens. The first one is characterized by homogeneous fibre distribution, $V_f = V_f^o$. The fibre distribution in the second one is highly non- homogeneous. A half of the cross-section does not have fibres at all, the other half has a homogeneous fibre distribution, $V_f = 2V_f^o$. The calculation was performed for two values of the non-dimensional fibre/matrix interface strength, $\alpha_1 = 0.1$ and $\alpha_2 = 0.4$.

The calculated dependencies are plotted in Fig. 2. Comparing the data obtained with the experimental data (Fig. 1) yields the following main conclusion:

If the fibre/matrix interface strength does not depend of fibre volume fraction, then the strongly non-homogeneous fibre packing will not yield a decrease in the creep resistance. The assumption mentioned does not applicable to the composites, of which creep behavior is like that shown in Fig 1.

ACKNOWLEDGMENTS

The work was supported by Russian Foundation for Basic Research, Project 11-03-01239.

REFERENCES

[1]-Mileiko,S.T., Metal and Ceramic Based Composites, Elsevier, Amsterdam, 1997.

Mileiko, S.T., Oxide-fibre/Ni-based matrix composites - III: A creep model and analysis of experimental data, Compos. Sci. and Technol., 2002, 62, p. 195-204.

[2]-Mileiko, S.T., V.M.Kiiko, A.A.Kolchin, V.P.Korzhov, and V.M.Prokopenko, Oxide-fibre/Ni-based matrix composites - II: Mechanical behaviour, Compos. Sci. and Technol., 2002, 62, p. 181-193.

[3]-Mileiko, S.T., Single crystalline oxide fibres for heat-resistant composites, Compos. Sci. and Technol., 2005, 65, p. 2500-2513.