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OXIDE FIBRES FOR HIGH TEMPERATURE APPLICATIONS

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SUMMARY

Single crystalline oxide fibres such as sapphire, garnets, mullite, are certainly much better reinforcements for heat-resistant composites than corresponding polycrystalline fibres. The only serious obstacle on their way to the composites is their extremely high cost due to a low productivity rate of a process based on the Stepanov's concept. The internal crystallisation method (ICM) allows overcoming this obstacle; however, the development of a real fabrication technology based on this method requires a study of the crystallisation process under special conditions of the method. Some new results of the study that yield the fibres of high creep resistance at temperatures up to 1600^{o}C and sufficiently high strength are discussed in the present paper.

Keywords: , oxide fibre, sapphire, garnet, mullite, single crystals, creep, strength

INTRODUCTION

The internal crystallisation method to produce single crystalline and eutectic fibres was outlined briefly for the first time nearly 20 years ago [1] and recently [2] in more details. The method being schematically simple requires a systematic study to become a base for a fabrication technology for producing fibres of high creep resistance at very high temperatures and of sufficiently high strength at room temperature. In the present paper, the microstructure and most important mechanical properties of sapphire, yttrium-aluminium garnet and mullite fibres are discussed in the connection to the fabrication regimes.

FIBRE CREEP RESISTANCE

The creep resistance of a single crystal does not certainly depend of its sizes. Therefore, if we manage to produce either really single crystalline fibres, as in the case of sapphire, or nearly single crystalline ones, aluminium-yttrium garnet being an example, their creep resistance does not differ from that of well studied properties of the bulk crystals [2]. The case of mullite, which is most interesting due to the information on possibly very high creep resistance of this crystal at high temperatures [3], is much more complicated and requires a special consideration. Such consideration has been accomplished and the highest creep resistance at high temperatures was recorded [4]. Creep resistance of mullite fibres is presented in Figure 1.

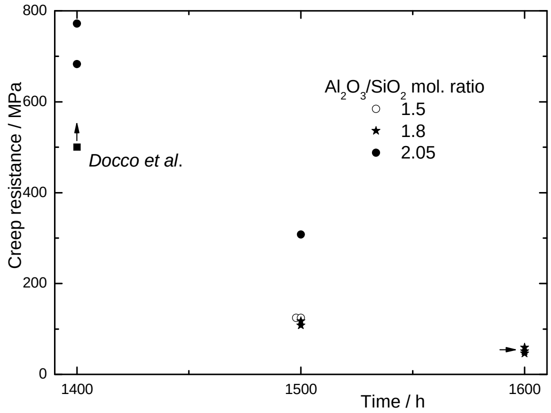

Figure 1. Creep resistance of mullite fibres crystallized from the precursors with various Al_2O_3/SiO_2 molar ratios. The point marked *Docco et al* is the only one obtained in testing mullite single crystal.

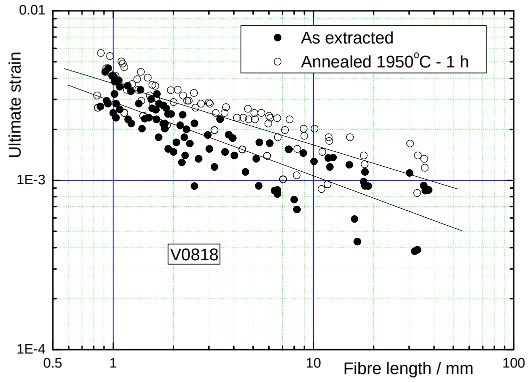

Figure 2. YAG-fibres: the ultimate strain versus fibre length for as extracted and annealed fibres.

FIBRE STRENGTH

Fibre strength can be enhanced by elimination of growth defects, decreasing the permanent strength by both smoothing the radial temperature gradients in the growth zone and annealing the fibres after crystallisation, and removing special defects in garners arisen as a result of an overheating of the melt. Here we just show an effect of the fibre annealing, Figure 2.

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