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SILICATE-BASED FIBRES TO REINFORCE HIGH TEMPERATURE COMPOSITES

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ABSTRACT

Yttrium and ytterbium silicates are attractive materials for the fibres to be used as reinforcement for high temperature composites. The internal crystallization method allows obtaining a variety of the oxide fibres. Hence, it was used to produce fibres containing the silicates mentioned. In the present paper, for the first time, systematic data on the microstructure and strength of the fibres are presented.

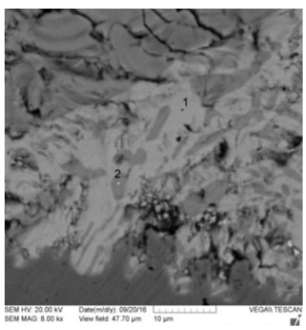
Keywords: composites, oxide fibres, yttrium silicates, ytterbium silicates, microstructure.

INTRODUCTION

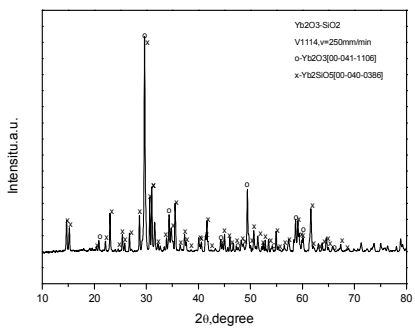
Yttrium and ytterbium silicates have been considering as effective materials for anti-oxidation coatings for ceramic and carbon based composites, (Xu, 2010; Ma, 2017). This makes such silicates attractive materials for the fibres to be used as reinforcement for high temperature composites. The internal crystallization method allows obtaining a variety of the oxide fibres (Mileiko, 2005). Hence, it was used to produce fibres containing the silicates mentioned. In the full-text paper systematic data on the microstructure and strength of the fibres are to be presented.

RESULTS AND CONCLUSIONS

Molybdenum-matrix composites reinforced with fibres of pure silicates Re2SiO5 and Re2Si2O5 and of the compositions close to the Re2O3-Re2SiO5 eutectics (Re = Y, Yb) were obtained with fibre crystalization rate from 10 to 250 mm/min. The fibre volume fraction was between 35 and 40%. An example of the eutectic fibre microstructure is presented in Figure 1(a); phase composition of the fibre is given in Figure 1(b). Composites were tested in 3-point bending at temperatures from 20 to 1400ºC, and then fibre strength values were calculated by using the strength data of the matrix, see Figure 2(a).



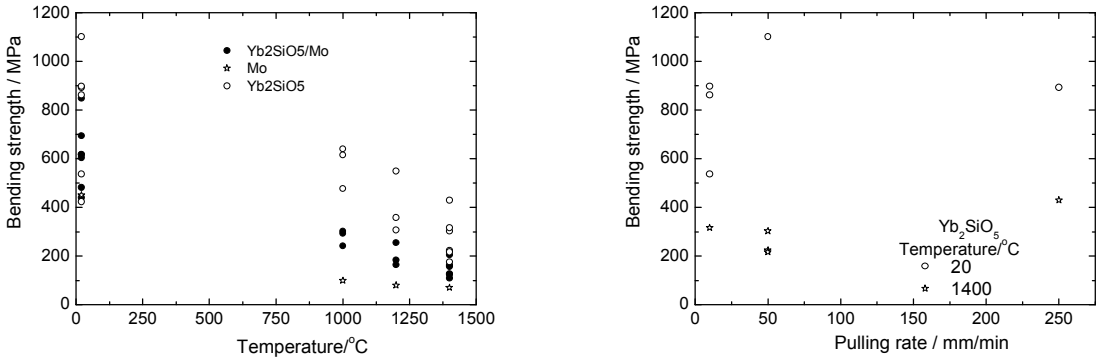
(a)



(b)

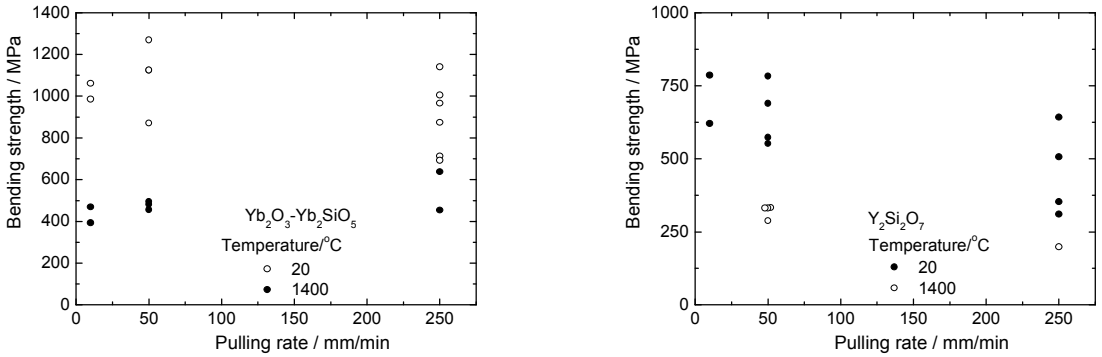
Fig. 1 - The microstructure (a) and X-Ray spectra (b) of a fibre crystallised from the Yb_2O_3-SiO_2 mixture corresponding to the Yb_2O_3-Yb_2SiO_5 eutectic.

The fibre strength/temperature dependencies are presented in Figures 2 and 3.



(a) (b)

Fig. 2 - (a) Temperature dependence of the strength of molybdenum matrix, Yb_2SiO_5-fibre/Mo-matrix composites and Yb_2SiO_5-fibres. (b) The effective Yb_2SiO_5-fibre strength at RT and 1400°C versus crystallisation rate of the fibres.



(a) (b)

Fig. 3 - The effective fibre strength at RT and 1400°C versus crystallisation rate of the fibres. (a) The fibres crystallised from the Yb_2O_3-SiO_2 mixture corresonding to the Yb_2O_3-Yb_2SiO_5 eutectic. (b) The Y_2Si2O_7-fibre.

We conclude that:

1. For the first time fibres containing yttrium and ytterbium silicates were obtained.
2. All the fibres are sufficiently strong up to a temperature of 1400°C.
3. The fibre strength depends on the crystallisation rate and this means that the fibre fabrication technology needs to be optimised.

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