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«SPINEL-GARNET FIBERS BASED ON ORGANOMAGNESIUMOXANE YTTRIUMOXANE ALUMOXANES»

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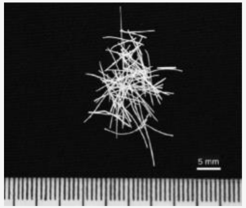
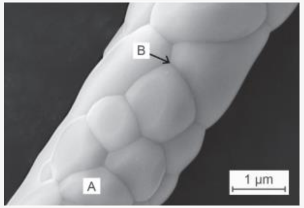
Introduction





Ceramic fibers of mixed oxide composition, for example, α-Al_2O_3 and t-ZrO_2, YAG-ZrO_2, α-Al_2O_3 and MgO [1,2] are in demand for the production of high-temperature ceramic composites with improved mechanical properties which are required for the manufacture of parts of aircraft and ground-based gas turbine engines, hypersonic missiles and aircraft as well as systems for thermal protection of spacecraft and hypersonic vehicles [3].

The oxides of the spinel and garnet structure have not only a high melting point (2135 and 1940 ^oC, respectively) but also a complex crystal structure that prevents the movement and propagation of cracks [1,2].

Chinese scientists described a method for producing oxide fibers of mixed composition: spinel-garnet (MAS/YAG) using sol-gel technology [4].

We have developed a method for producing fibers of mixed oxide composition: alumomagnesium spinel ($MgAl_2O_4$) and yttrium aluminum garnet ($Y_3Al_5O_{12}$) from a melt of a pre–ceramic polymer - organomagnesiumoxane yttriumoxane alumoxanes [5].

Results and discussion

The production of fibers of mixed oxide composition $MgAl_2O_4$ /$Y_3Al_5O_{12}$ is carried out as follows: 200 g of fiber-forming organomagnesiumoxane yttriumoxane alumoxanes with a molar ratio of Al:Y≈6 and Al:Mg≈2 are loaded in small portions into the extruder of the molding machine preheated to 110 ^{o}C. The speed of rotation of the receiving spool is set at 250 rpm for pulling and winding the polymer fiber. Then the wound polymer fiber (Fig. 1.1) is removed from the receiving spool, placed on a corundum mat and placed in an oven for further heat treatment (Fig. 1.2). Heating is carried out in an air atmosphere according to the following mode: from room temperature to 500 ^{o}C at a speed of 1 C/min – fiber curing (Fig. 1.3), from 500 ^{o}C to 1300-1500 ^{o}C at a speed of 10 ^{o}C/min with exposure for 10 min. Heat treatment is carried out in an atmosphere of air. As a result, ceramic fibers of mixed oxide composition $MgAl_2O_4$/$Y_3Al_5O_{12}$ are obtained (Fig. 1.4).

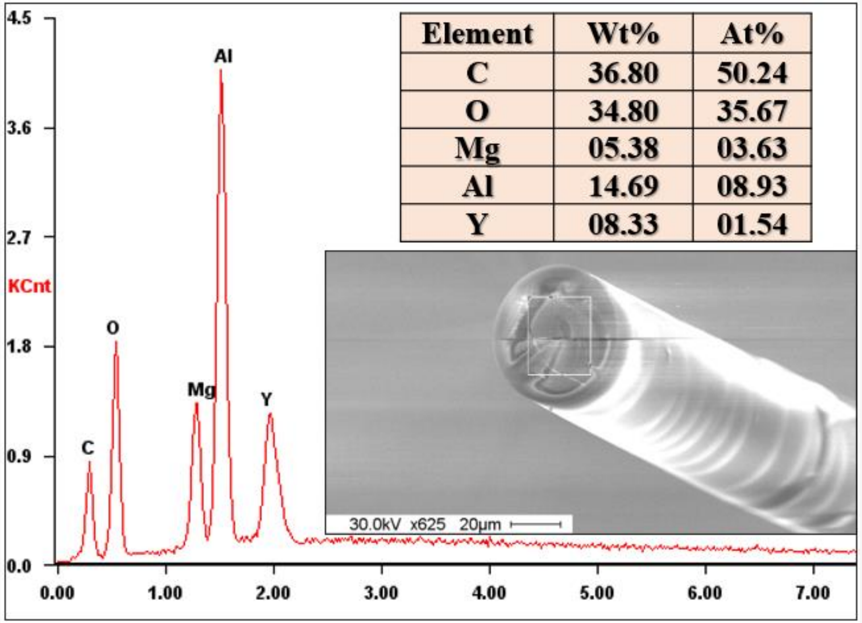
Results and discussion

1 **2** **3** **4**

Fig. 1 The process of obtaining ceramic fibers of mixed oxide composition $MgAl_2O_4/Y_3Al_5O_{12}$: 1,2 – photo of polymer fiber; 3 – cured fiber at 500 °C; 4 – ceramic fiber pyrolyzed at 1300 °C

Results and discussion

The elemental composition of the polymer fiber is shown in Fig. 2.1, and the ceramic fiber in Fig. 2.2



Element	Wt%	At%
C	36.80	50.24
O	34.80	35.67
Mg	05.38	03.63
Al	14.69	08.93
Y	08.33	01.54

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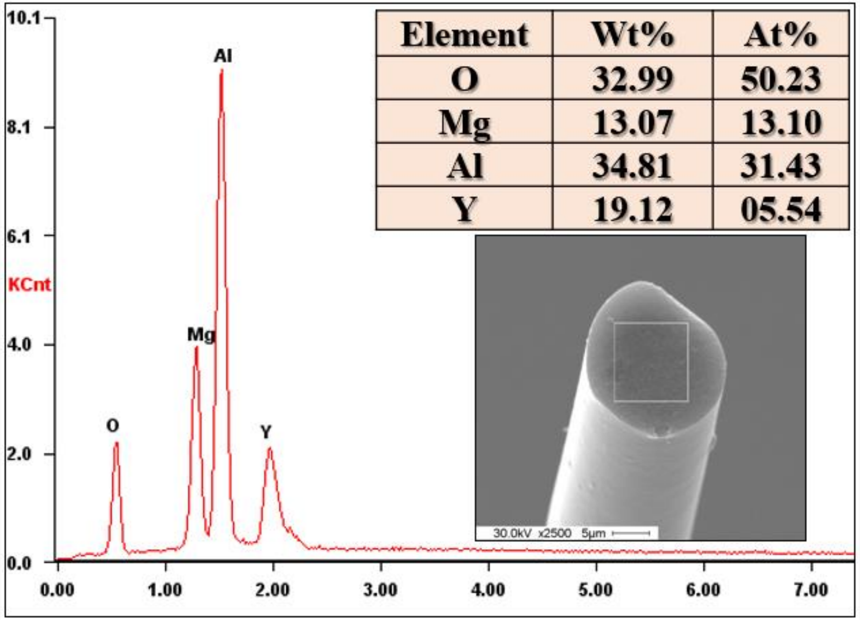


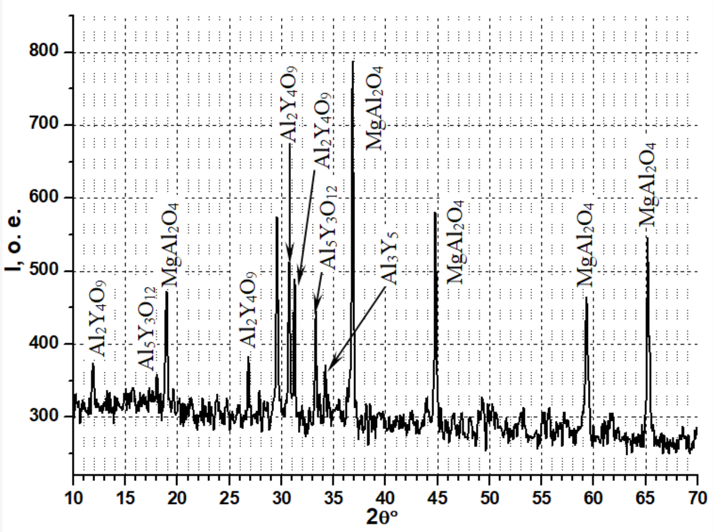
Element	Wt%	At%
O	32.99	50.23
Mg	13.07	13.10
Al	34.81	31.43
Y	19.12	05.54

2

Fig. 2 SEM image and X-ray elemental microanalysis: 1 – polymer fiber; 2 – ceramic fiber pyrolyzed at 1300 °C

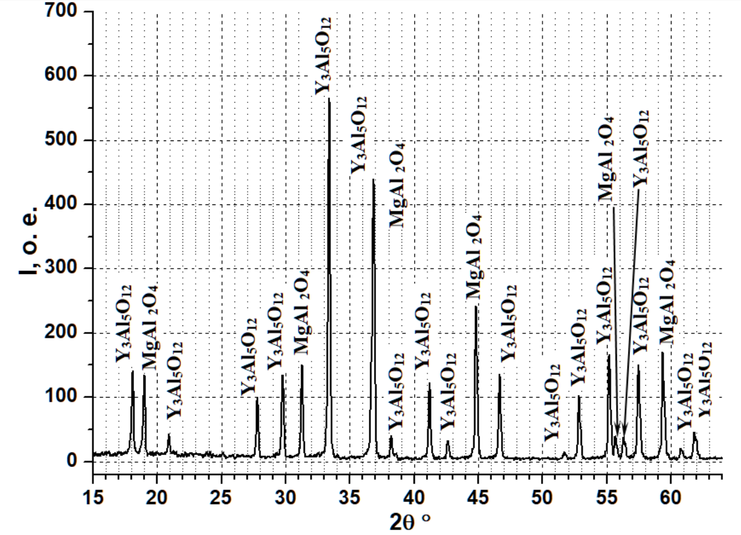
Results and discussion

The phase composition of $MgAl_2O_4/Y_3Al_5O_{12}$ ceramic fibers based on organomagnesiumoxane yttriumoxane alumoxanes with a molar ratio of Al:Y≈6 and Al:Mg≈2 obtained at different temperatures was proved by the XRD method.



$MgAl_2O_4$ – 79 wt%; $Al_2Y_4O_9$ – 17 wt%; $Al_5Y_3O_{12}$ – 4 wt%

1



$MgAl_2O_4$ – 77 wt%; $Al_5Y_3O_{12}$ – 23 wt%

2

Fig.3 Diffractogram of ceramic fiber $MgAl_2O_4/Y_3Al_5O_{12}$ pyrolyzed at: 1 – 1300 ºC; 2 – 1500 ºC

Results and discussion

Tensile tests show that the fibers that cure at 500 ºC have strength of 150-300 MPa, however, further heat treatment of the cured fibers up to 1300 ºC leads to an increase in strength up to 800 MPa.

Conclusion

The method for producing ceramic fibers of mixed spinel-garnet composition $MgAl_2O_4/Y_3Al_5O_{12}$ by melt spinning of fiber – forming oligomers to produce polymer fibers at 80-180 ºC with a molar ratio of Al:Y≈6 and Al:Mg≈2 and further stepwise heat treatment in air at 500, and 1300-1500 ºC is developed. It is found that polymer fibers heat-treated up to 1300 ºC have a tensile strength of about 800 MPa.

References

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