EXPERIMENTAL STUDY OF FORMATION PROCESS OF Mg-Fe-CHRYSOTILES UNDER HYDROTHERMAL CONDITIONS

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Key words: mechanism and kinetics, nanotubular chrysotiles, evolution of precursors.

To determine the regularities of formation of nanotubular chrysotiles under hydrothermal conditions the investigation of the mechanism and kinetics of the formation of chrysotiles with different content of iron oxides was undertaken. The iron oxides practically always present in the composition of natural chrysotile-asbtstos.

The nanotubular chrysotiles with the different iron content were synthesized by hydrothermal treatment of Mg-Fe-enstatites with 10-35 mass% FeO in water and NaOH aqueous solutions at temperatures 250-450°C and pressures 10-100MPa (tabl. 1).

Table 1. Chemical composition of synthesized Mg- and Mg-Fe-nanotubular chrysotiles, mass.%

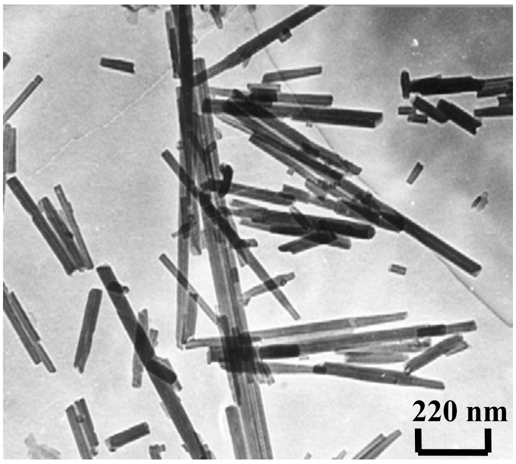
Oxides	From enstatite $MgSiO_3$	From initial enstatites with different content of FeO, mass.%		
		10 %	15 %	25 %
	Samples			
	1	2	3	4
SiO_2	43.03	40.46	40.46	40.21
MgO	42.42	38.98	35.58	31.25
FeO	-	5.38	7.35	9.85
Fe_2O_3	-	1.94	3.08	5.83
H_2O^+	13.50	12.65	12.63	12.30
H_2O^-	1.10	0.45	0.78	0.63
Summary	100.05	99.86	99.88	100.07

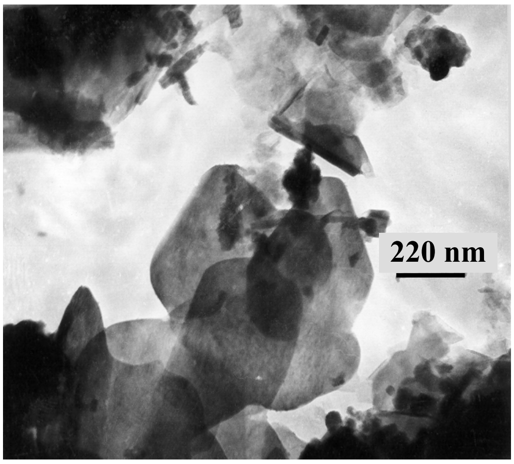
It was discovered that a part of Fe^{2+} ions of initial enstatites oxidates during their treatment to Fe^{3+} and enters into the octahedral and tetrahedral layers of chrysotile structure. It was established the maximum of iron incorporation into chrysotiles, to $Fe^{2+}_{0.40}$ $Fe^{3+}_{0.20}$, at which the formation of cylindrically curved layers in their structures is possible. This process leads to the formation of nanotubes (fig. 1a). The introduction of iron in greater quantities into precursors leads to the crystallization lamellar Mg-Fe- serpentines (fig. 1b). It was set that the introduction of iron into precursors visibly influences on the crystallization conditions of the chrysotile nanotubes and its morphology, dimensions and properties (tabl.2)

Table 2. Characteristics of synthesized Mg - and Mg-Fe- nanotubes

Sample	Dimensions of nanotubes			Optical constants			$V_{u.c.}$, Å^3
	Length, µm	Diameter, nm		Ng	Np	Ng-Np	
		outer	inner				
1	1-15	20-25	4	1.547	1.542	0.005	714.8
2	1-10	20-30	4-5	1.560	1.554	0.006	no determ.
3	1-10	25-35	5	1.575	1.566	0.009	717.1
4	0.5-5	30-50	5-6	1.590	1.581	0.009	719.4

Sample denotations in table 2 are given according to the data of table 1.





a *b*

Fig.1. *a* –nanotubes $(Mg,Fe)_3Si_2O_5(OH)_4$, synthesized in 1.5% NaOH solution at a temperature of 350°C and a pressure of 70 MPa.
b – Mg-Fe-serpentine with lamellar form of participles.

The multistage character of precursors evolution at synthesis of Mg-Fe- chrysotiles under hydrothermal conditions was explained. This is due to distinctions in formation rate of interminate (brucite, talc, montmorillonite) and terminal phases. The sequence and rate of chrysotile formation under hydrothermal conditions (fig. 2) are determinated by FeO amount in the precursors, composition of hydrothermal solutions and temperature of the treatment. The distinction of rate of chrysotile formation can be explained by different solubility of precursors with various FeO amount in their composition under hydrothermal conditions.

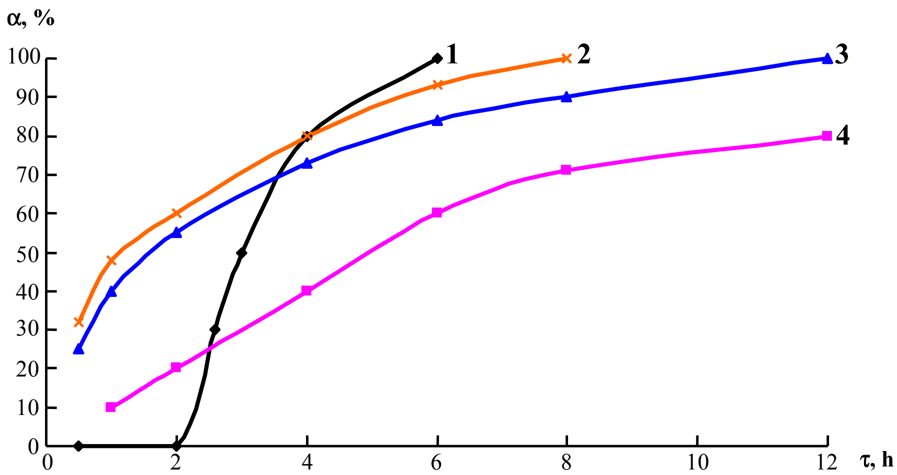


Fig.2. Kinetics of crystallization of nanotubular chrysotiles in NaOH solutions at a temperature of 350°C and a pressure of 70 MPa from mixtures of $MgSiO_3$ and $(Mg, Fe)SiO_3$.
α - is the degree of transformation, %.

Numbering of the samples is given according to the table 1.

The work was completed at financial support RFBR (grant 04-03-32293)

Published on July, 1, 2006