Effect of MoO_3 and TiO_2 Partical Size on Dysprosium Titanate Pellets Phase Composition and Density

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The industrial production of dysprosium titanate powder, a neutron-absorbing material for VVER-1000 reactor, is carried out by high-temperature sintering of oxide mixtures or by induction melting of oxide mixtures in a cold crucible followed by crushing and sieving of powders into fractions.

Basic requirements for powder:

- no unreacted starting oxides;
- the main phase - a fluorite-, pyrochlor- or hexagonal-type structure.

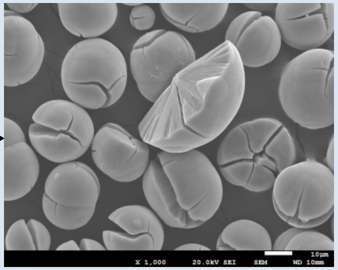
The high pellet density of > 6.6 g/cm^3 at the stage of dysprosium titanate synthesis ensures high bulk density of produced powder, which allows to achieve the required density of absorber material.

Purpose of work: Comparative study of the synthesis of dysprosium titanate based on two compositions with the same content of dysprosium oxide with or without the dopant element MoO_3, and investigation of the effect of TiO_2 powder particle size on the phase composition and pellet density.

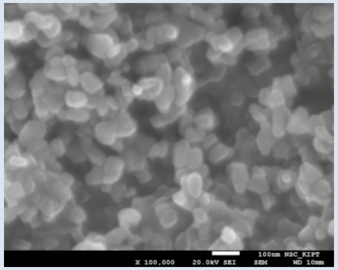
81,2%Dy_2O_3+ 18,8%TiO_2 (I)
81,2%Dy_2O_3+ 15,8%TiO_2+3,0%MoO_3 (II)

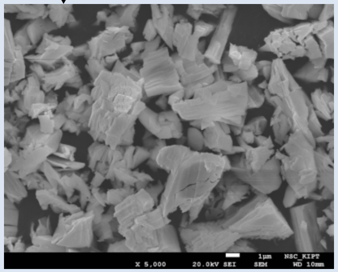
Initial materials:
TiO_2 (99.9%, ОСЧ 7-3, spec. 6-09-3811-79),
Nano TiO_2 (99.95%, China Rare Metal Material),
Dy_2O_3(99.5%, China Rare Metal Material),
MoO_3 (99.9%, чда, spec. 6094471-77).

30 mkm



25 nm





Dysprosium titanate pellet manufacturing scheme:

Mixing in distilled water in a Pulverisette 6 mill (Fritch), adding a plasticizer - polyethylene glycol (PEG-100), pressing pellets Ø10mm at 200 MPa, sintering in air at temperatures:1450 ºC and 1650 ºC for 3 and 6 hours in a furnace (HT 16/17 P470 Naberterm).

Temp/ time	ρ, g/cm^3	Phase (wt., %)
		(I), TiO_2 (ОСЧ 7-3)
1450/3	5,84	Dy_2O_3(17,3); $Dy_2Ti_2O_7$-p (35,1); Dy_2TiO_5-h (15,7); Dy_2TiO_5-p(31,9)
1650/3	-	Dy_2O_3(10,1) ; $Dy_2Ti_2O_7$-p(24,4); Dy_2TiO_5-h(14,8); Dy_2TiO_5-f(23,5); Dy_2TiO_5-p(27,2)
1650/6	6,53	Dy_2O_3(4,7); $Dy_2Ti_2O_7$-p (18,7); Dy_2TiO_5-h(13,6); Dy_2TiO_5-f(26,7); Dy_2TiO_5-p(36,3)
		(II), TiO_2 (ОСЧ 7-3)
1450/3	5,86	Dy_2TiO_5-p (78,2); Dy_2TiO_5-h (15,1); $Dy_2Ti_2O_7$-p (6,7)
1650/3	-	Dy_2TiO_5-p (100)
1650/6	6,8	Dy_2TiO_5-p (100)
		(I), Nano TiO_2 (CRMM)
1450/3	5,44	Dy_2O_3 (5,6); $Dy_2Ti_2O_7$-p (26,4); Dy_2TiO_5-h(54,6); Dy_2TiO_5-p(13,4)
1650/3	-	Dy_2TiO_5-h (100)
1650/6	6,91	Dy_2TiO_5-h (100)
		(II), Nano TiO_2 (CRMM)
1450/3	6,37	Dy_2TiO_5-p (87,7); Dy_2TiO_5-h (10,2); $Dy_2Ti_2O_7$-p (2,1)
1650/3	-	Dy_2TiO_5-p (100)
1650/6	7,1	Dy_2TiO_5-p (100)

Conclusion:

1. The possibility of varying the characteristics of dysprosium titanate pellets with after reaching the required density and phase composition using different types (grades) of initial TiO_2 and the dopant element MoO_3 has been shown.
2. The incorporation of MoO_3 promotes intensification of the sintering process, increasing pellet density to 6.8 g/cm^3 and formation of a monophase pyrochlore-type structure, regardless of the type of initial TiO_2.
3. The use of nanosized TiO_2 powder in an undoped composition results in increasing the density of sintered dysprosium titanate pellets to 6.9 g/cm^3 and formation of an equilibrium monophase hexagonal-type structure.
4. The use of nanosized TiO_2 powder together with MoO_3 leads to an increase in the density of sintered dysprosium titanate pellets to 7.1 g/cm^3 and formation of a monophase pyrochlore-type structure.