Analysis of Isothermal Sintering of Zinc-Titanate Doped with MgO

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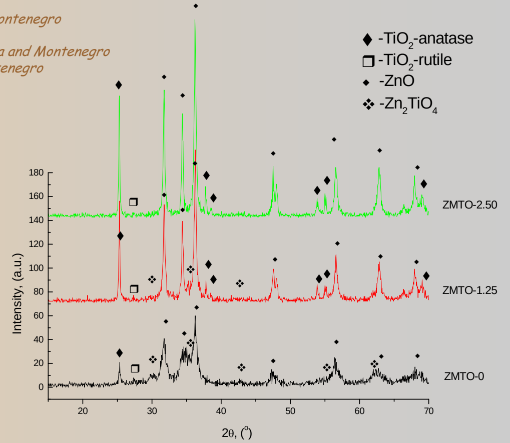
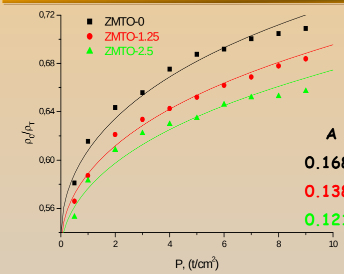
Abstract

The aim of this work was analysis of isothermal sintering of zinc titanate ceramics doped with MgO. Mixtures of ZnO, TiO_2 and MgO (0, 1.25 and 2.5%) were mechanically activated 15 minutes in a planetary ball mill. The powders obtained were pressed under different pressures and the results were fitted with a phenomenological compacting equation. Isothermal sintering was performed in air for 120 minutes at four different temperatures and the sintering kinetics was analyzed using a phenomenological equation. Structural characterization of ZnO-TiO_2-MgO system after milling was performed at room temperature using XRPD measurements. DTA measurements showed different activation energies for pure and doped ZnO-TiO_2 systems. The main conclusions are that doped zinc titanate samples achieve higher densities after sintering and that addition of MgO stabilizes the crystal structure of zinc titanate.



X-ray diffraction patterns of mechanically activated starting mixtures with different amounts of MgO

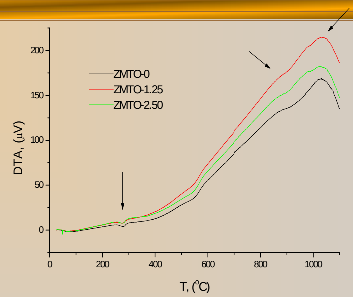


Ratio of relative density in dependence on the compaction pressure

R. Panelli, F. A. Filho

$$\ln\left(\frac{1}{1-D}\right) = A\sqrt{P} + B$$

A	B
0.1687	0.7678
0.1389	0.7492
0.1217	0.7378



DTA curves of powder mixtures

Kissinger

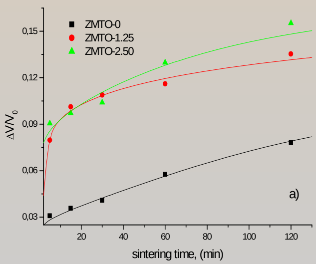
$$\ln\left(\frac{\beta}{(T_p)^2}\right) = C - \frac{E_a}{R}\cdot\left(\frac{1}{T_p}\right)$$

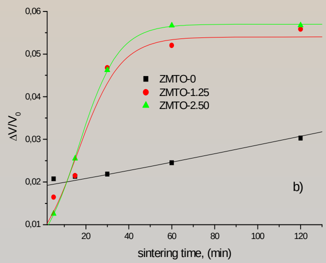
Ea
182.3 $KJmol^{-1}$
224.7 $KJmol^{-1}$
325.1 $KJmol^{-1}$

$$\frac{\Delta V}{V_0} = \frac{K}{1 + C\exp(-st)}\cdot(st)^n$$

K (1100°C)	K (1000°C)
0.089	0.064
0.07	0.054
0.146	0.057

$n^{-1} > 2 \Rightarrow$ grain boundary diffusion mechanism!





Cinc-titanate ceramics with MgO addition sintered isothermally at a) 1100°C and b) 1000°C

Conclusions

The phase composition in ZnO-TiO_2 solid solutions with the addition of MgO = 0-2.50 wt.% along with the compaction process, thermal behavior and a detailed analyses of isothermal sintering was studied. The main conclusions are:

-MgO is a very rigid and stable oxide and is situated around ZnO and TiO_2 particles that are brittle and soft compared to MgO particles and therefore obstructs both mechanical treatment and the beginning of the mechanochemical reaction. Activation energies calculated from DTA measurements confirmed our statement.

-The density values of compacts decreased with MgO addition although all mixtures follow the same function with increase in pressing pressure, and can be fitted well with Panelli and Filho's compaction equation,

-Densities of all three mixtures increase with sintering temperatures reaching their maximum for mixtures with MgO addition at 1100°C, as expected. Also, the proposed mechanism for isothermal sintering is grain boundary diffusion.