Synthesis and Characterization of Zirconia-Alumina Nanocomposites Obtained by Spark Plasma Sintering

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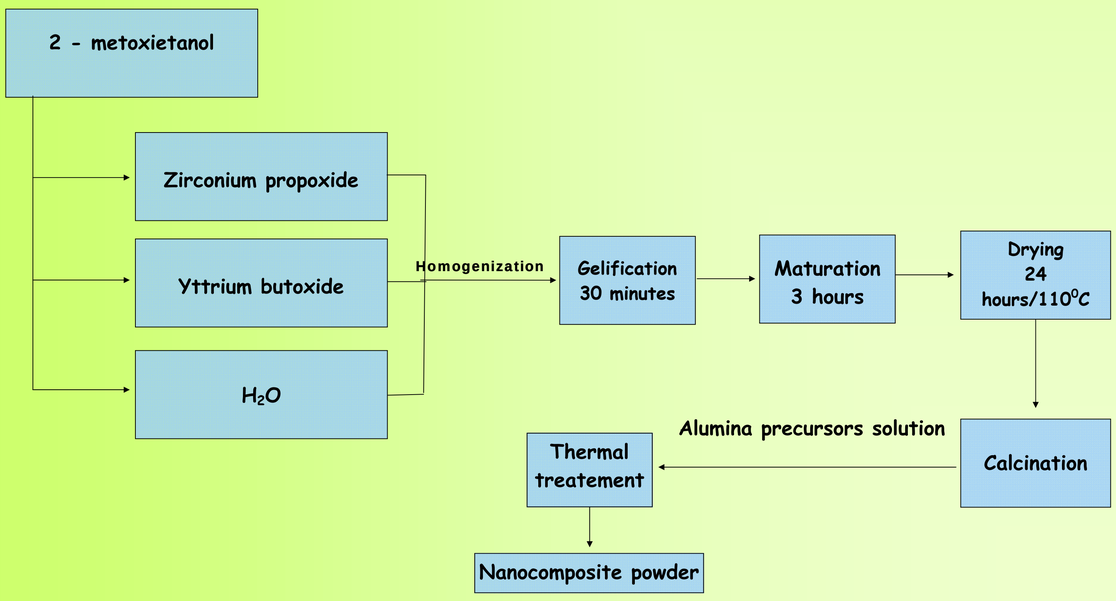
1.INTRODUCTION

The aim of this study is to obtain cubic zirconia nanocomposites with 5 to 15 % alumina. In order to achieve fine microstructure and homogeneous dispersion of alumina particles in the zirconia matrix, at the nanometer level, a sol-gel method is used. Previously, the zirconia nanopowder is stabilised in the cubic form with 10 mol% yttria, also using a sol-gel route. The stabilized zirconia powders were characterised using DTA, X-Ray diffraction, scanning electron microscopy and transmission electron microscopy with selected area electron diffraction. The nanocomposite powders were obtained by mixing the calcinated zirconia nanopowders with an alumina precursor solution and after that heat treated to remove all organic residues. The nanocomposites were sintered using spark plasma sintering at 1250°C for 5 minutes. The obtained ceramics were characterised using X-Young module and 700 to 890 Hv for the micro hardness.

2.EXPERIMENTAL

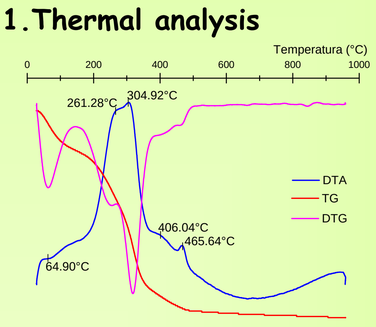
Nanopowders synthesis



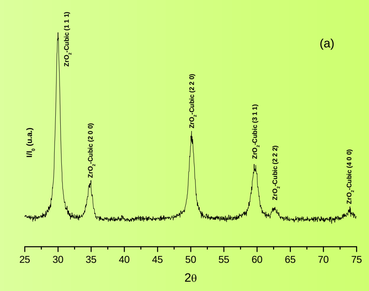
3.RESULTS

3.1.Zirconia nanopowder characterization (Heat treated at 700°C/2 hours)

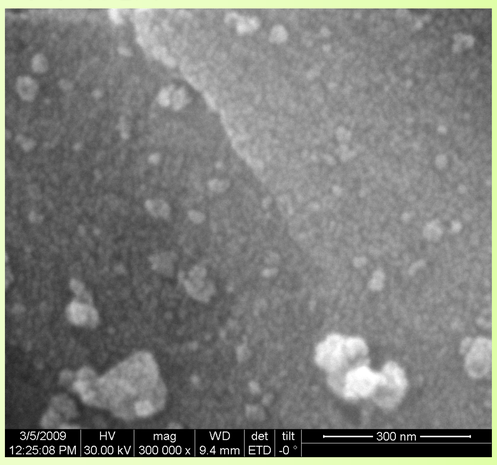
3.1.1.Thermal analysis



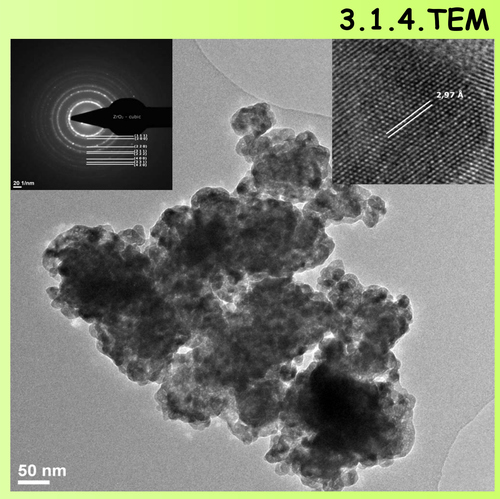
3.1.2.X-Ray diffraction



3.1.3.SEM

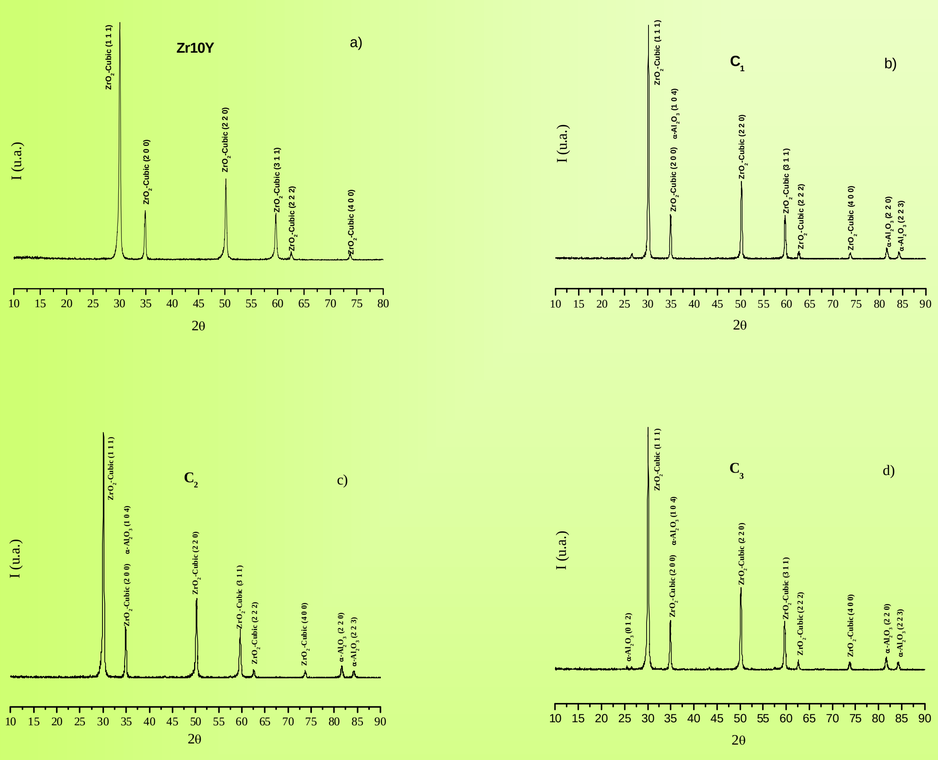


3.1.4.TEM

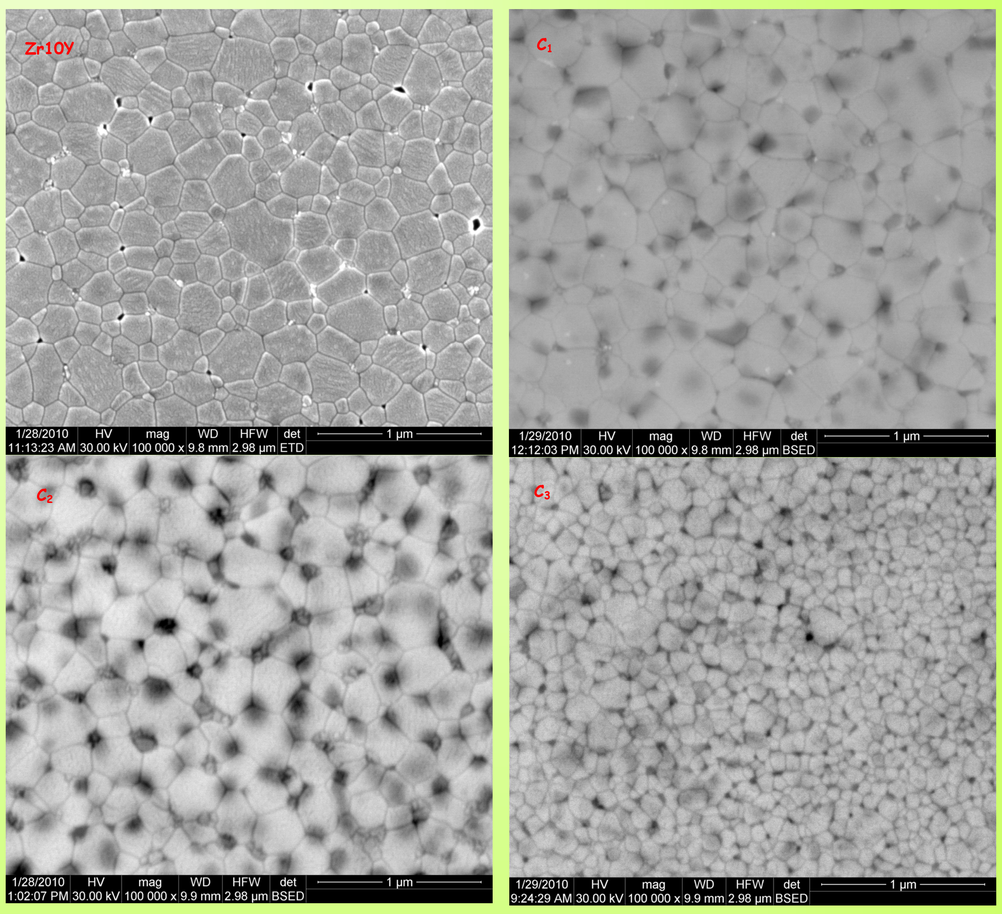


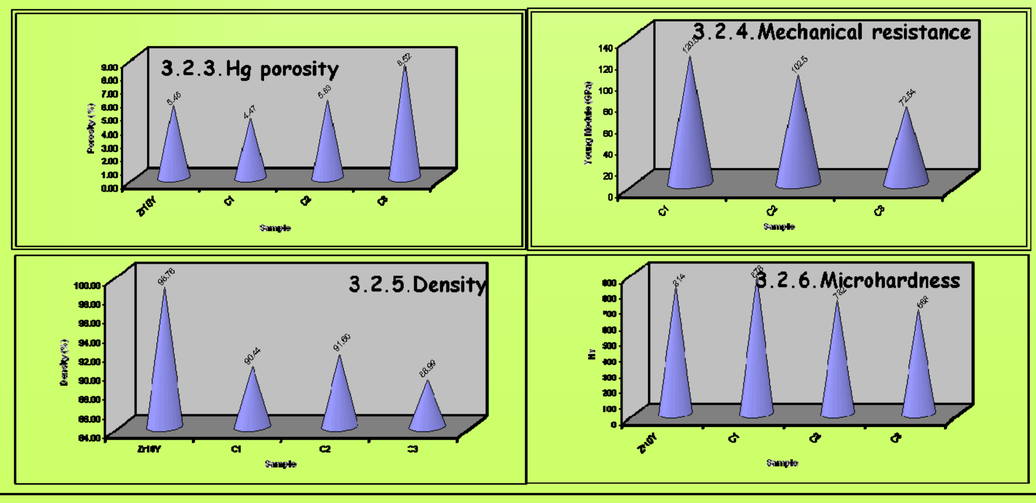
3.2.Zirconia-alumina nanocomposites characterization (sintered through SPS at 1250°C/5 minutes)

3.2.1.X-Ray diffraction



3.2.2.SEM





4.Conclusions

The stabilized zirconia nanopowders are characterized by a cubic structure, determined through X-Ray diffraction and SAED and have an average grain size of approximately 17 nm, as determined by transmission electron microscopy.

In the cubic zirconia – alumina nanocomposites obtained, the average grain size of cubic zirconia is of approximately 100 nm and 60 nm for the alpha alumina. The total porosity of samples is in the range of 4 to 8%, with a relative density reaching 92% of the theoretical density. The mechanical strength tests results are in the range of 90 to 120 GPa for the Young module and 700 to 890 Hv for the micro hardness.

In conclusion, it can be assumed that the nanocomposites prepared have promising characteristics and properties that make them good candidates for applications in various fields.