Efeect Of TiO_2 Additives To The Sintering Of Y_2O_3

Tarik Talib Issa , Kawakib Jassim Majeed , Harith J.Ibrahim

University of Baghdad , College of science, Physics department , Jadiriya ,Baghdad ,IRAQ

Abstract . The effect of sintering additive on the microstructure development of yttrium oxide was investigated . Different combinations of yttrium oxide with TiO_2 were used as sintering additive. The x-ray diffraction , differential thermal analysis (DTA) were investigated and microstructure of resulting compacts were characterized by , using scanning electron microscopy , porosity and sintering density for all compacting samples sintered at different sintering temperature under static air .

Keywords : Sintering , DTA , Microstructure ,TiO2

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INTRODUCTION

Sintering is a manufacturing process in which a fine powder that has been formed into a shape is subsequently fired at high temperature .The compact ,then fired, densities and becomes non-porous .More formally ,sintering is a thermal treatment that bonds particles together into a solid ,coherent structure by means of mass transport mechanisms occurring largely at the atomic level A.[(1)] variety of new ceramics has been developed in the last twenty years. These are of particular interest because they have either unique or outstanding properties and greater chemical receptivity or they have been discovered more or less accidentally and have become an important part of the industry

Because there is a real need for new materials to transform presently available designs into practical serviceable products. By far the major hindrance to the development of many new technologically feasible structures and systems is the lack of satisfactory materials. Advanced ceramics.[(2)] re constantly filling this need. Other new ceramic materials unknown ten or twenty years ago are no being manufactured . Form this point of view the ceramic industry is one of our most rapidly changing industries with new products having useful properties constantly being developed, these ceramics.

Y2O3 is a refractory material using in coating crucibles ,tubers and nozzles for improved resistance to molten titanium and metals . As ceramic it is a super-excellent media for high brightness laser and Yttria – stabilized zirconia was used in alumina – zirconia abrasives , bearings and seals ,high temperature refractories for continuous –casting nozzles ,jet-engine coating ,oxygen sensors in automobile engines, and wear-resistant and corrosion –resistant cutting tools .

Experimental work

The Y2O3 and TiO2 powder , was analyzed for particle sizes ranging between 50 -70 microns were generally utilized as starting materials throughout the present investigation .

TiO2 at varying fractions (1, 2, and 3 wt. %) was dry mixed with Y2O3 by using mixing technique. Discs of 2 cm. diameter were compacted, three samples for each weight percentage were prepared.

Sintering was performed at a various temperatures ranging from (700, 900 ,1100 ,1300) C° for 2 hours under static air . X-ray diffraction and differential thermal analysis DTA ,for the combination Y2O3 - 3 wt.% TiO2 were done , DTA was done at 5 C° per mint and from (25 – 1000) C°.in an ambit atmosphere. .Densification measurements were based on volumes determined using micrometer measurements and accurate weight measured by an electronic balance .

Microstructure examination was carried out for the sintered specimens using Jeol - Jsm - 6400 scanning electron microscope equipped with secondary electron image (SET) and back scattered electron image (BEI) .

RESULTS AND DISCUSSION.

Figure. (1) shows the x-ray diffraction pattern for the sintered combination Y2O3- 3 wt.% TiO2 sintered at 1300 C^o , its very clear form its profile that there is no any phase changes after adding TiO2 as sintering aid and the resulting spectrum is belongs to Yttria . Thermal analysis (DTA) , gives a consistency results with x-ray diffraction ,by no phase transformation (Exo.) can be notes after the sintering and adding titanium dioxide , while decomposition notes at 60 C^o, which is belong to the water molecules caused by the surrounding atmosphere as shown in figure (2) . Figure(3) shows the sintering density of the Y2O3 - 1,2and 3 wt.% TiO2 ,sintered at various sintering temperature under static air for 2 hours. The compacts containing 1 wt.% TiO2 showed an slightly increasing in density followings by rabid increasing in sintered density of (2.72 gm./cm3) for the 2 wt.% TiO2 sintered at 1300 C^o . Whereas the compacts containing 3 wt.% TiO2 showed the increasing in density of maximum value (2.80 gm./cm3) , sintered at 1300 C^o . Sintering temperature at 1300 C^o also effecting the porosity to be reduced for Y2O3 and Y2O3 - wt.% TiO2 from (7.60) and to be at a lowest value (7. 20) for the Y2O3 - 3 wt.% TiO2 , which giving the consistency with the sintering behavior ,[3] as shown in figure (4) .

The micro structure investigation of the ceramic compacts showed results consistent with the sintered densities .Some representative SEM micrographs for samples sintered at 1300 C^o. for 2 hours in air are shown in figure (5) . The compact containing 1 wt.% TiO2 showed evidence of the fine 10 micron pours indicated in figure.(5,a) .Whereas the compact containing 2 wt.% TiO2 showed the intermediate phase sintering of 10 micron coarse particle size , begins when adjacent necks begin to impinge upon each other , densification and grain growth occur during this stage with open –pore structure.[4] particle size as indicated in figure.(5,b) , comparing with the 3wt.% TiO2 as shown in figure (5,c) , the grain growth with closed pours indicate the presence of the final stage of sintering caused by TiO2 particles that improve sintering activity of Y2O3 powder through the bulk transport mechanism result in net particle movement leading to the densification. [5] [6] [7] .

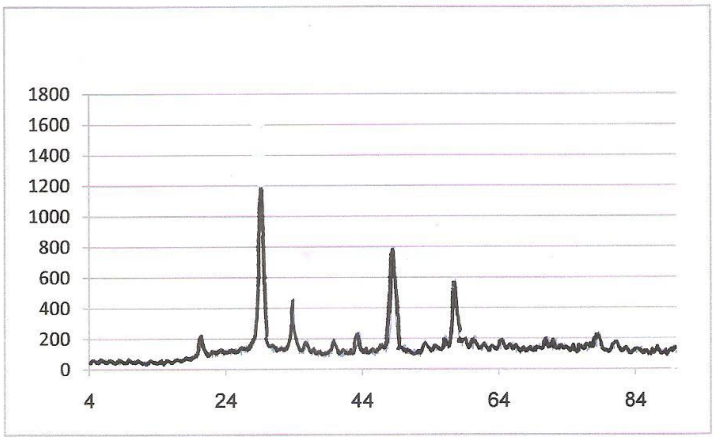


FIGURE1. The x-ray diffraction pattern of Y_2O_3 – 3 wt. % TiO_2 ceramic compacts , sintered at 1300 C^o , for 2 hours under static air .

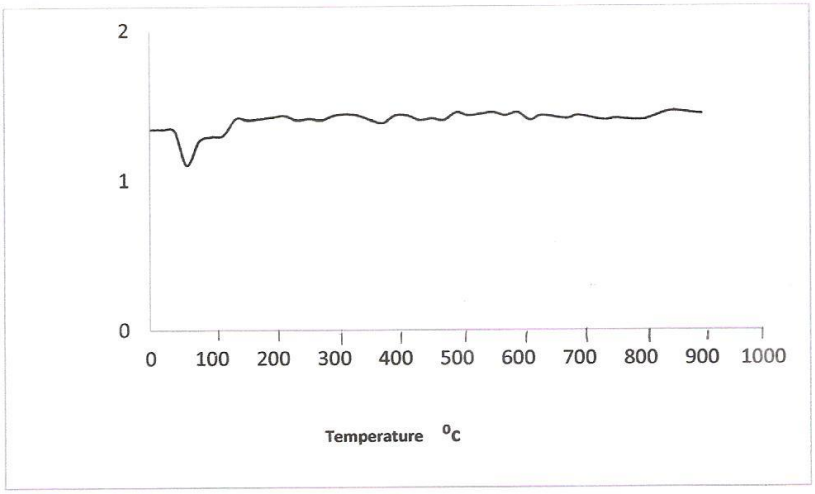


FIGURE 2 . The DTA curve of Y_2O_3 – 3 wt.% TiO_2 ceramic compacts , sintered at 1300 C^o for 2 hours under static air .

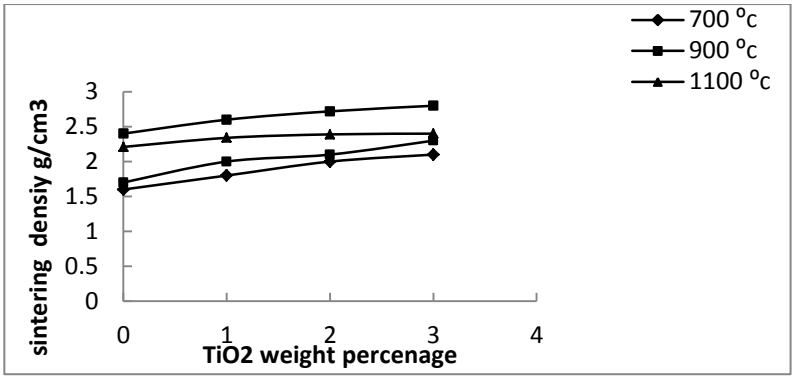


FIGURE 3. The sintering density of Y_2O_3 – TiO_2Wt% ceramic compacts , sintered at different sintering temperature for 2 hours under static air .

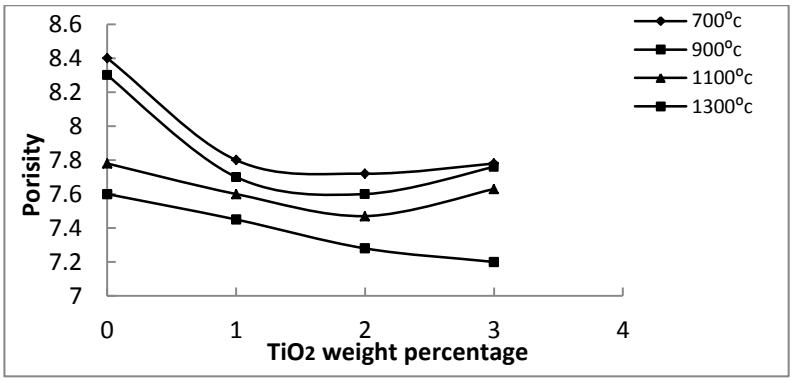
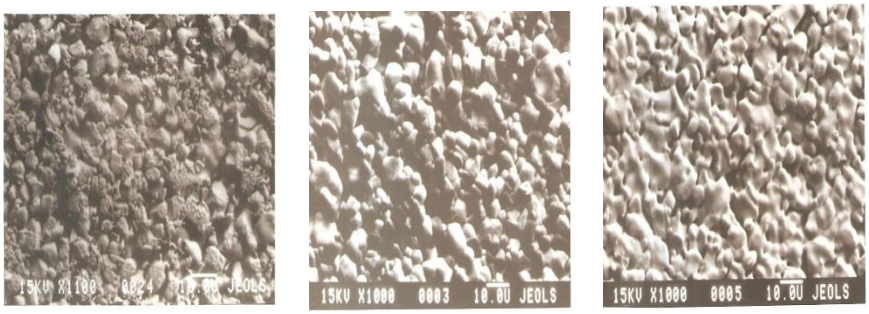


FIGURE 4. The porosity of Y_2O_3 – TiO_2 Wt% ceramic compacts , sintered at different sintering temperature for 2 hours under static air .



(a) (b) (c)

FIGURE 5 . SEM micrographs for a) Y_2O_3 - TiO_2 1 Wt.% , b) Y_2O_3 – TiO_2 2 Wt. % c) Y_2O_3- TiO_2 3 Wt.% , sintered at 1300 C^o for 2 hours under static air .

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CONCLUSION

The densification of the Y2O3 – TiO2 wt.% ceramics compacts increased at all sintering temperatures and indicate a higher sintering density at 1300 C^0 , for the combination Y2O3 –TiO2 3wt.% shows the final sintering stage with a grain growth of 10 microns and close pour . TiO2 was found to improve the sintering activity of Y2O3 and without any effecting to its crustal structure . .

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