Efeect Of V_2O_5 Additives To The Sintering Of Y_2O_3

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Abstract . The effect of sintering additive on the microstructure development of yttrium oxide was investigated at different sintering temperature (700,900,1100,1300) C° under static air . Different combinations of yttrium oxide with V_2O_5 were used as a ceramic composite material .

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 reflected the optimum values for the combination Y_2O_3 –3Wt.% V_2O_5 sintered at temperature 1300 C° . Mechanical properties representative by hardness and compression were tested . Brake down voltage and dielectric strength were measured for all compacted samples sintered at 1300 C° under static air .

Introduction

Yttria has received great attention in various fields of advanced applications due to its excellent properties such us high dielectric constant(14-18),low absorption in broad range (near – UV to IR),superior electrical brake – down (> 3MV/Cm) and low leakage current [1].The remarkable luminescence render it widely be used in fluorescent lighting ,color television ,computer monitors ,flat panel display ,X-ray imaging and amplifiers for fiber –optics communication [2] [3] .

Its 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 [4] .

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, densifies 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 [5]. 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 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 [6]. In the present work we are focusing on improvement in the microstructure of Yettria by adding additives oxide like vanadium penta oxide ,which showed a great effecting at different sintering temperature comparing with other oxide [7] .

Experimental

The Y_2O_3 and V_2O_5 powder , was analyzed for particle sizes ranging between (50 -70) microns were generally utilized as starting materials throughout the present investigation.V_2O_5 at varying fractions (1, 2, and 3 wt. %) was dry mixed with Y_2O_3 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 was carried out by SHEMADU XRD – 600 (Japan) , and differential thermal analysis ,DTA by using LINSEIS STA (Germany) ,for the combination Y_2O_3 - 3 wt.% V_2O_5 were done , DTA was done at 5 C° /min. 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 scanning electron microscope SEM –VEGA,TESCAN (Geake Republic) . Hardness and compression strength tested to .Finally brake down voltage and dielectric strength were tested for the all combination sintered at 1300 C°, under static air .

Results and Discussion

Fig. 1, shows the x-ray diffraction pattern for the sintered combination Y_2O_3-wt.%V_2O_5 sintered at 1300 C^o , its very clear form its profile that there is no any phase changes after adding V_2O_5 as sintering aid and the resulting spectrum is belongs to Yttria. [8] Thermal analysis (DTA), gives a consistency results with x-ray diffraction ,by no phase transformation (Exo.) [8] , can be notes after the sintering and adding vanadium pent oxide , while decomposition notes at 65 C^o, which is belong to the water molecules caused by the surrounding atmosphere as shown in Fig . 2 .In Fig. 3 , we can observe the sintering density of the Y_2O_3(1,2and 3 wt.% V_2O_5 ,sintered at various sintering temperature under static air for 2 hours. All The compacts containing wt.% V_2O_5 showed an increasing in density with maximum value reached at (2.92gm/cm3) for the combination Y_2O_3 – V_2O_5 3 Wt.% sintered at 1300 C^o . Sintering process also effecting the porosity to be reduced for Y_2O_3 and Y_2O_3- wt.% V_2O_5 respectively from (8.40) and to be at a lowest value (7.08) for the

Y_2O_3-3 wt.% V_2O_5 sintered at 1300 C^o , which giving the consistency with the sintering behavior [8], as shown in Fig. 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 Fig. 5. The compact containing 1 wt.% V_2O_5 showed evidence of the fine 50 micron of grain size, indicating the first sintering stage Fig. 5a .Whereas the compact containing 2 wt.% V_2O_5 showed the intermediate sintering stage 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 [9] [10] , Fig. 5b, comparing with the 3wt.% V_2O_5 as shown in Fig. 5c, the grain growth of 5 micron with closed porosity indicate the presence of the final stage of sintering caused by V_2O_5 particles that improve the sintering activity of Y_2O_3 powder through the bulk transport mechanism result in net particle movement leading to the densification [11] [12] [7].Which shows a significant increase in both hardness and compression strength especially at the combination Y_2O_3 – 3Wt.% V_2O_5 ,as shown in Table 1. And the same effect can be identify for the brake down voltage and dialectical strength having a maxim value of 22.5 (Kv) , and 4.59(Kv/mm) ,respectively, as shown in Table 2 .

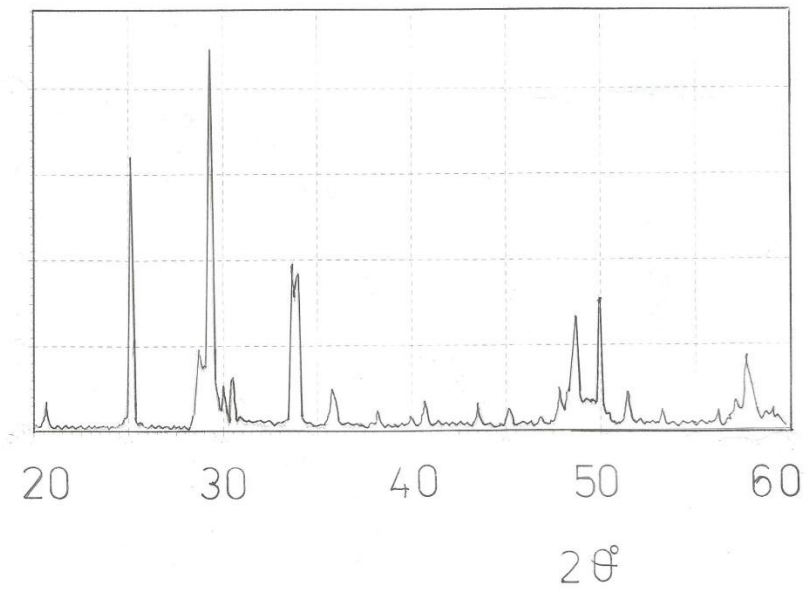


Figure. 1 , The x-ray diffraction pattern of Y_2O_3 – wt. % V_2O_5 ceramic compacts , Sintered at 1300 C^o, for 2 hours under static air.

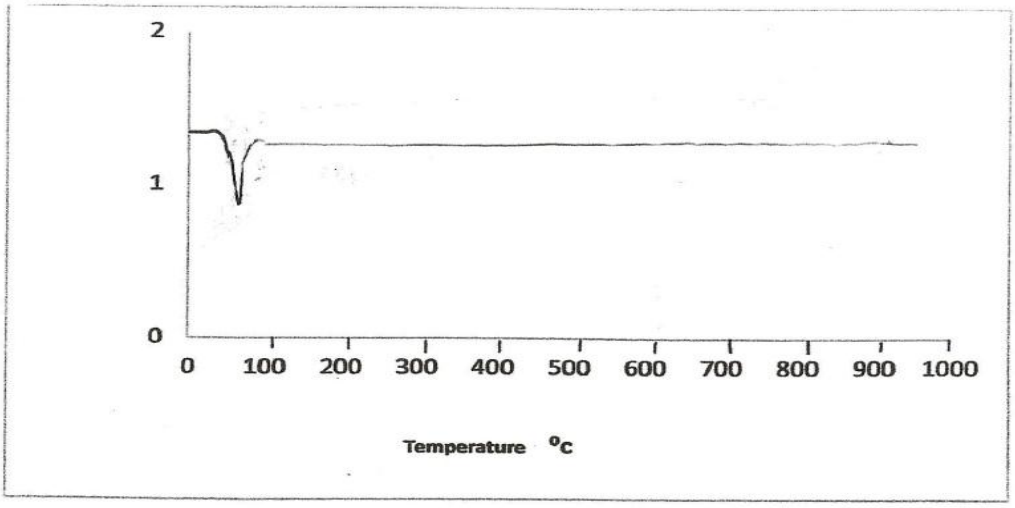


Figure. 2 ,The DTA curve of Y_2O_3 – wt.% V_2O_5 ceramic compacts , sintered at 1300 C^o for 2 hours under static air .

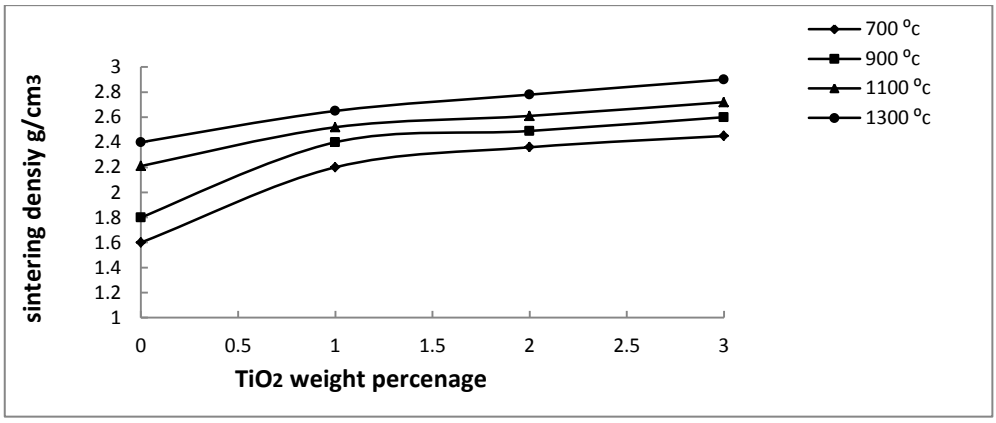


Figure. 3 ,The sintered density of Y_2O_3 –Wt. V_2O_5 % ceramic compacts , sintered at different sintering temperature for 2 hours under static air .

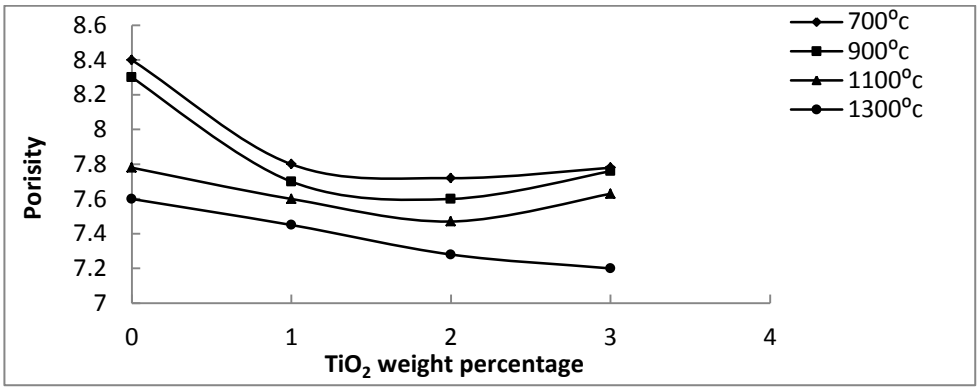
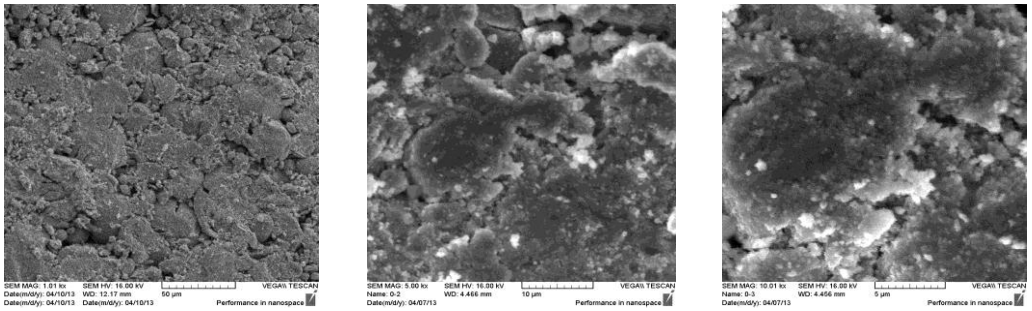


Figure. 4, The porosity of Y_2O_3 –Wt.V_2O_5 % ceramic compacts , sintered at different sintering temperature for 2 hours under static air .



(a) (b) (c)

Figure. 5, SEM micrographs for a) Y_2O_3 –1 Wt%. V_2O_5 of 50 mμ grain size , b) Y_2O_3 –2 Wt.% V_2O_5 10mμ grain size, c) Y_2O_3- 3 Wt. V_2O_5 % , 5mμ grain size. Sintered at 1300 C^o for 2 hours under static air .

TABLE 1. The Vickers hardness and compression Strength for the ceramic composite Y_2O_3- Wt.% V_2O_5 sintered at 1300c ,for 3 hours under static air .

Ceramic Compacts	Vickers hardness (MPa)	Compression (MPa)
Y_2O_3 – V_2O_5 1Wt.%	23 . 91	1.30
Y_2O_3 – V_2O_5 2Wt.%	28.97	10.47
Y_2O_3 –V_2O_5 3Wt.%	30.21	12.31

TABLE 2. The Brake down voltage and the dielectric strength for the ceramic composite Y_2O_3- Wt.% V_2O_5 sintered at 1300c ,for 3 hours under static air

Ceramic Compacts	Brake down Voltage (kv)	Dielectric strength (kv/mm)
Y_2O_3 – V_2O_5 1Wt.%	14.4	2.53
Y_2O_3 –V_2O_5 2Wt.%	16.5	3.09
Y_2O_5 – V_2O_5 3Wt.%	22.5	4.59

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