COMPARATIVE EVALUATION OF MICROSTRUCTURAL FEATURES OF UNI-AXIALLY AND HOT ISOSTATICALLY PRESSED ALUMINA ZTA CERAMICS

Pandu Ramavath[*1], Pappula Laxminarayana[2] and RoyJohnson[3]
[1,3]International Advanced Research Centre for Powder Metallurgy and New Materials, Balapur, Hyderabad-500 005, India
[2]Department of Mechanical Engineering, University College of Engineering, Osmania University, Hyderabad, India

Abstract: Alumina and zirconia toughened alumina powder were characterized for the properties such as phase purity, particle size and surface area. Both formulations were uni-axially pressed in a compaction die and pressure less sintered at 1550ºC to achieve close to theoretical density. For the sake of comparison, the formulations were also vacuum encapsulated and Hot Isostatically Pressed into identical density values at 1350ºC and 150MPa pressure. Specimens processed by both techniques were evaluated for the microstructure and fractographs are recorded. Based on microscopic studies the possible mechanisms for the evolution of microstructural features is proposed in the present study. Results will be presented during the conference.

***Index Terms*:** Ceramics; Uniaxial Compaction; Isostatic Compaction; Fractography

1. INTRODUCTION

Achieving full density in combination with finer grain sizes is always a challenge in ceramic processing. In order, to achieve these objective two processing techniques namely vacuum encapsulation and Hot Isostatic Pressing and uni-axial compaction and pressure less sintered are comparatively evaluated. Accordingly, alumina and zirconia toughened alumina powder formulations were vacuum encapsulated and Hot Isostatically Pressed at 1350ºC and 150MPa pressure. The samples were also uni-axially pressed in a compaction die and pressure less sintered at 1550ºC to achieve close to theoretical density[1-3].

2. Experimental Procedure

Commercially available Al_2O_3 and zirconia toughened alumina powder particle sizes sizes (D_{50}) of 9.8 µm, 124 µm and XRD patterns are shown in Fig.1 (a) and (b). Both formulations were uni-axially pressed in a compaction die and pressure less sintered at 1450-1550ºC to achieve close to theoretical density. The powders were also vacuum encapsulated and hot isostatically pressed into identical density values at 1350ºC and 150MPa pressure to fully densification process [4-5].

Specimens processed by both techniques were subjected to microstructure and fractographs evaluation on microscopic studies and the possible mechanisms for the evolution of microstructural features is proposed in the present study [6-9].

Results and Discussions

Alumina and zirconia toughened alumina powder formulations were characterized and the results are shown in Fig 1. Alumina powder has shown an average particle size of 9.8 µm and ZTA powders have shown the particle size of 124 µm respectively. Powders have also shown phase purity by based on the XRD patters shown in Fig.2 (a) and (b)

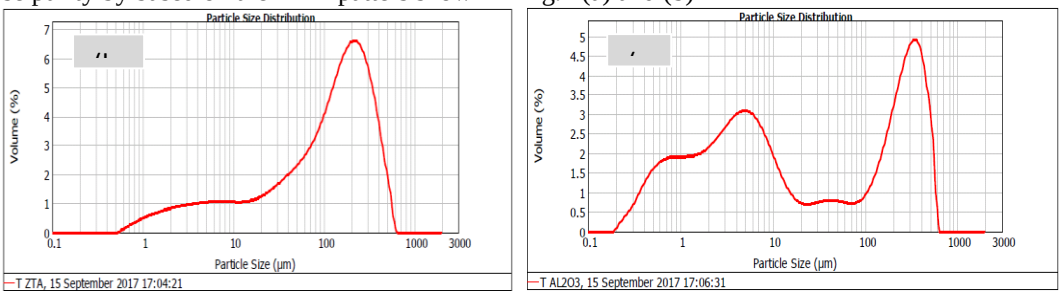

Fig.1: Particle size distribution curves of (a) Alumina (b) ZTA

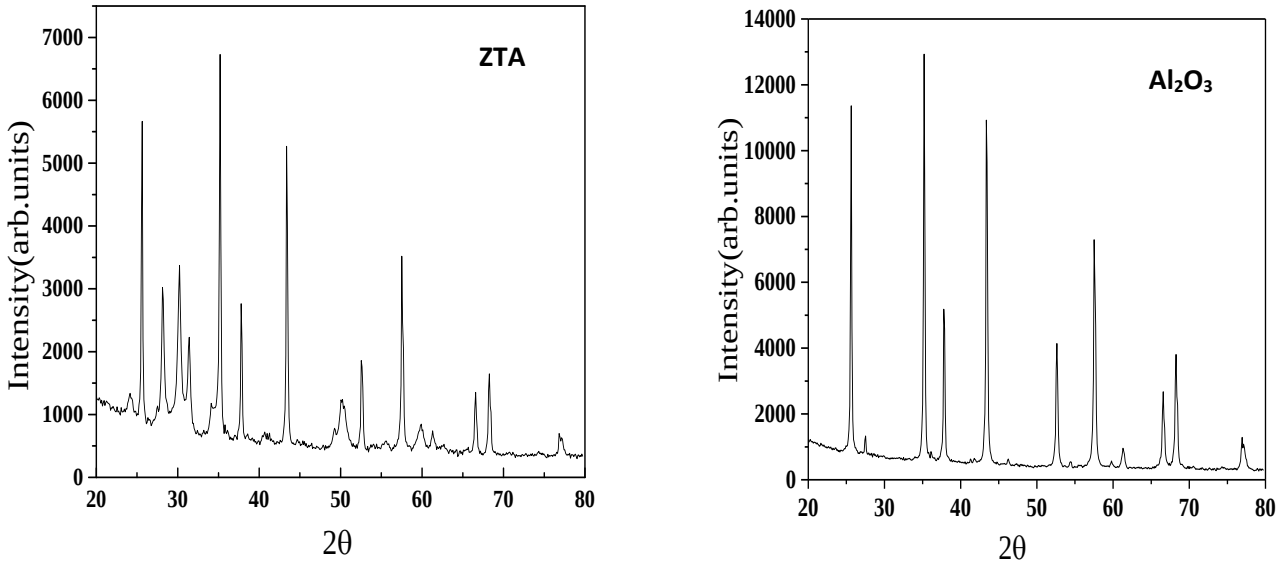

Fig.2: X-ray diffraction pattern of (a) Alumina (b) ZTA

Design of encapsulation can and the fabricated SS 316 L cans are shown in Fig.3 (a) and (b). The powder was filled in the can with the aid of a vibrating set up to ensure the powder maximum packing.

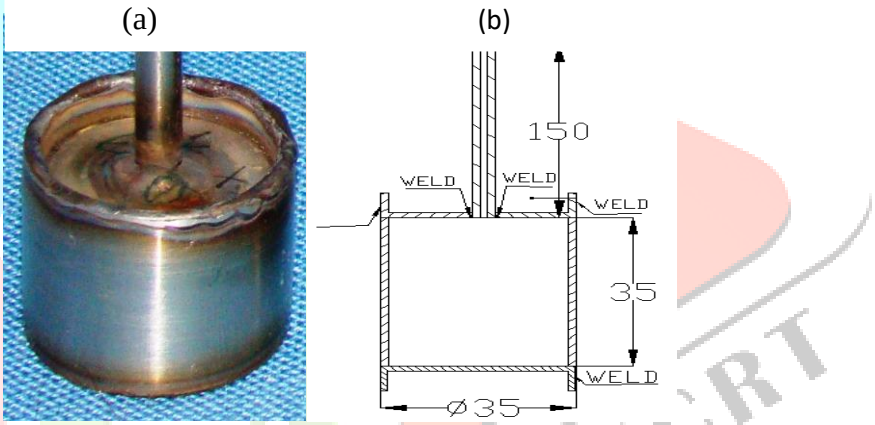

Fig.3: (a) SS 316L Can design (b) fabricated SS can

Uni-axially pressed alumina samples pressure less sintered at 1450ºC and ZTA samples sintered at 1550ºC achieved a density of 98.2% and 99% of respectively and close to theoretical density. During HIP due to the simultaneous application of temperature and pressure it is expected to have higher densities with narrower grain size distribution than the pressure less sintered samples. SEM microstructure of the thermally etched sample is shown in Fig. 4 (a) and (b). Fig 4 (a) it is evident that the microstructure of alumina shows well packed grains with average grain size of 5 µm complimenting the density values. Fig.4(b) of ZTA samples have shown a highly uniform grain sizes with zirconia particle pinning the grain growth.

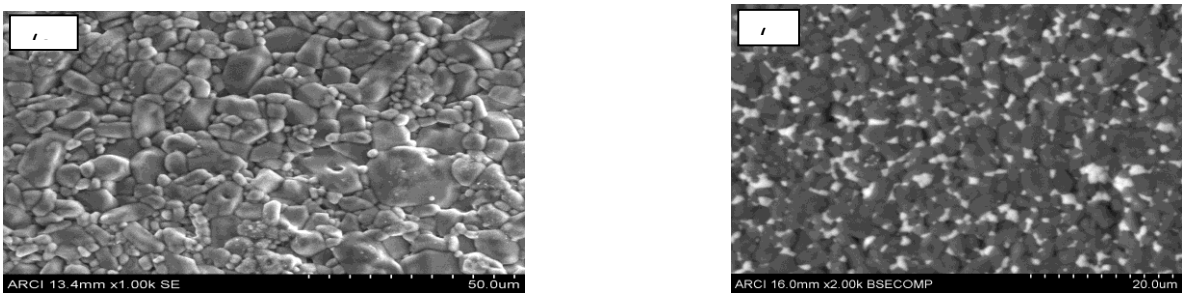

Fig.4: (a) Microstructure of Alumina (b) ZTA

4. CONCLUSIONS

1. Alumina and zirconia toughened alumina powder were characterized for the XRD phase and particle size analysis and the both samples exhibited phase purity and the average particle size was found to be 5 µm and 3µm respectively.
2. Alumina and zirconia toughened alumina powder was pressureless sintered to the density of 98.2% and 99% of respectively complemented by the microstructure. Sintered alumina microstructures have shown exaggerated grain growth however, pinning of grains by zirconia are evident in case of ZTA

3. Unlike uniaxial pressing which involves shaping followed by densification process, single step densification achieved through powder HIPing is expected to provide more density with finer grain size which is under investigation.

5. REFERENCES

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