DEVELOPMENT OF SILICON NITRIDE BASED CNT/GRAPHENE COMPOSITE USING HOT ISOSTATIC PRESSING (HIP) TECHNIQUE.

Awais Qadir [1,2] – Zsolt Fogarassy[2] – Zsolt E. Horváth[2]- Katalin Balázsi [2] – Csaba Balázsi [2]

[1]Doctoral School on Materials Science and Technologies. Óbuda University, Bécsi út 96/B, 1034 Budapest, Hungary

[2] Institute for Technical Physics and Materials Science, Centre for Energy Research, HAS, Konkoly-Thege M. str. 29-33, 1121 Budapest, Hungary

Introduction

Many researchers have studied the effect of oxidation on the mechanical properties of Si_3N_4 but this oxidation was done on the surface of sintered Si_3N_4 in the form of oxide scaling and they found the degradation in mechanical properties due to the flaws in oxide scale but it protects the internal material [1, 2].

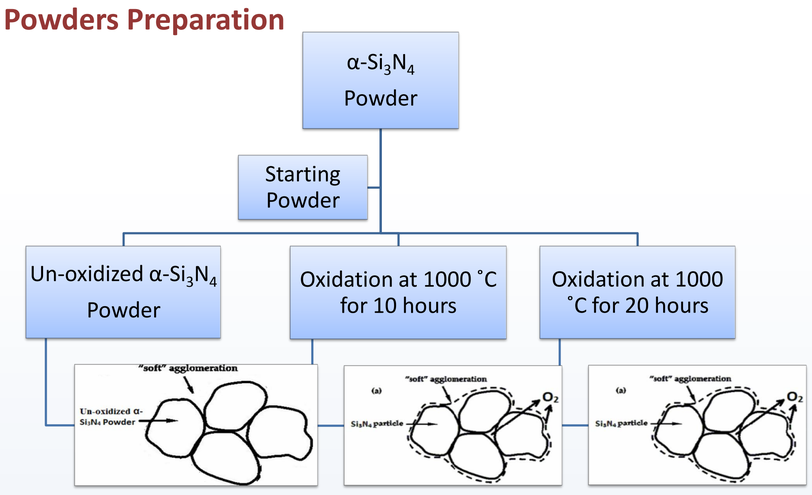
Best to our knowledge, no researcher studied the effect of nano oxidized silicon nitride powder particles on the mechanical properties of hot-sintered silicon nitride material. The starting silicon nitride powder characteristics have a significant influence on the final properties of densified product and surface modifications of starting powder might have effects on the structural and mechanical properties of densified material.

Aim of work

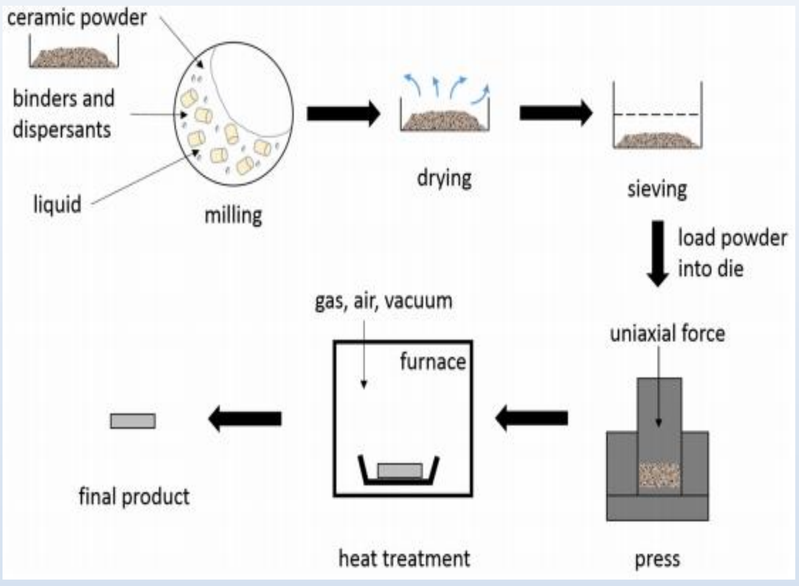
In this work, the effect of nano-oxidized powder particles and sintering temperatures on the structural and mechanical properties of the hot-sintered silicon nitride materials was studied. The starting powders α-Si_3N_4 were oxidized at 1000 ˚C for 10 and 20 hours and these oxidized powders were densified at 1500˚C and 1700˚C using hot-isostatic pressing technique. This approach will be applied in future work with the addition of CNTs and graphene to observe the effect of CNTs and oxides on the properties of whole material.

Materials & Methods

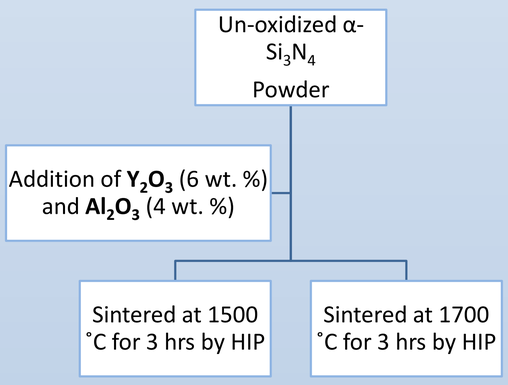
Powders Preparation



Schematic diagram of preparation



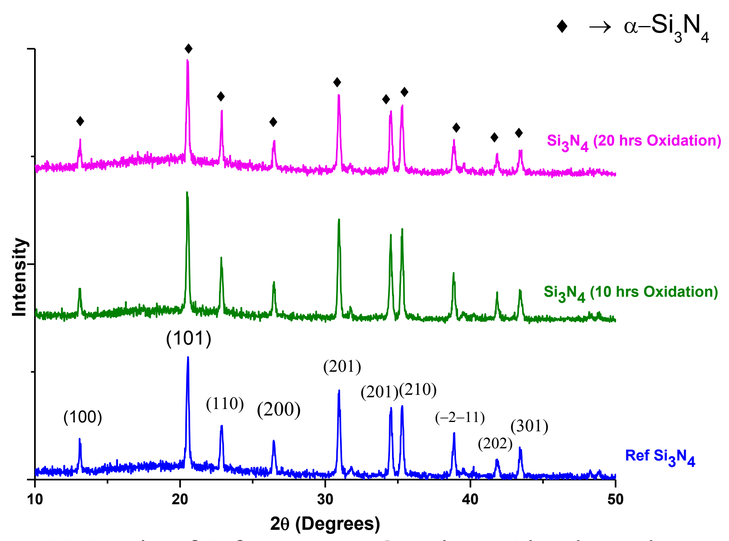
Sintering Process



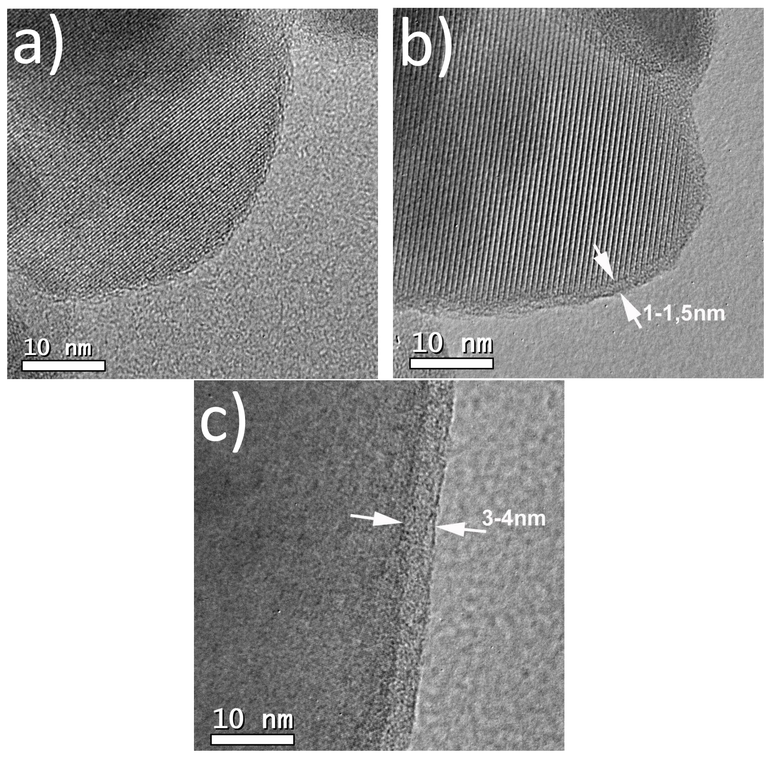
The same sintering strategy was adopted for 10 & 20 hrs oxidized powders.

Structural investigations

Characterization of Base and Oxidized Powders

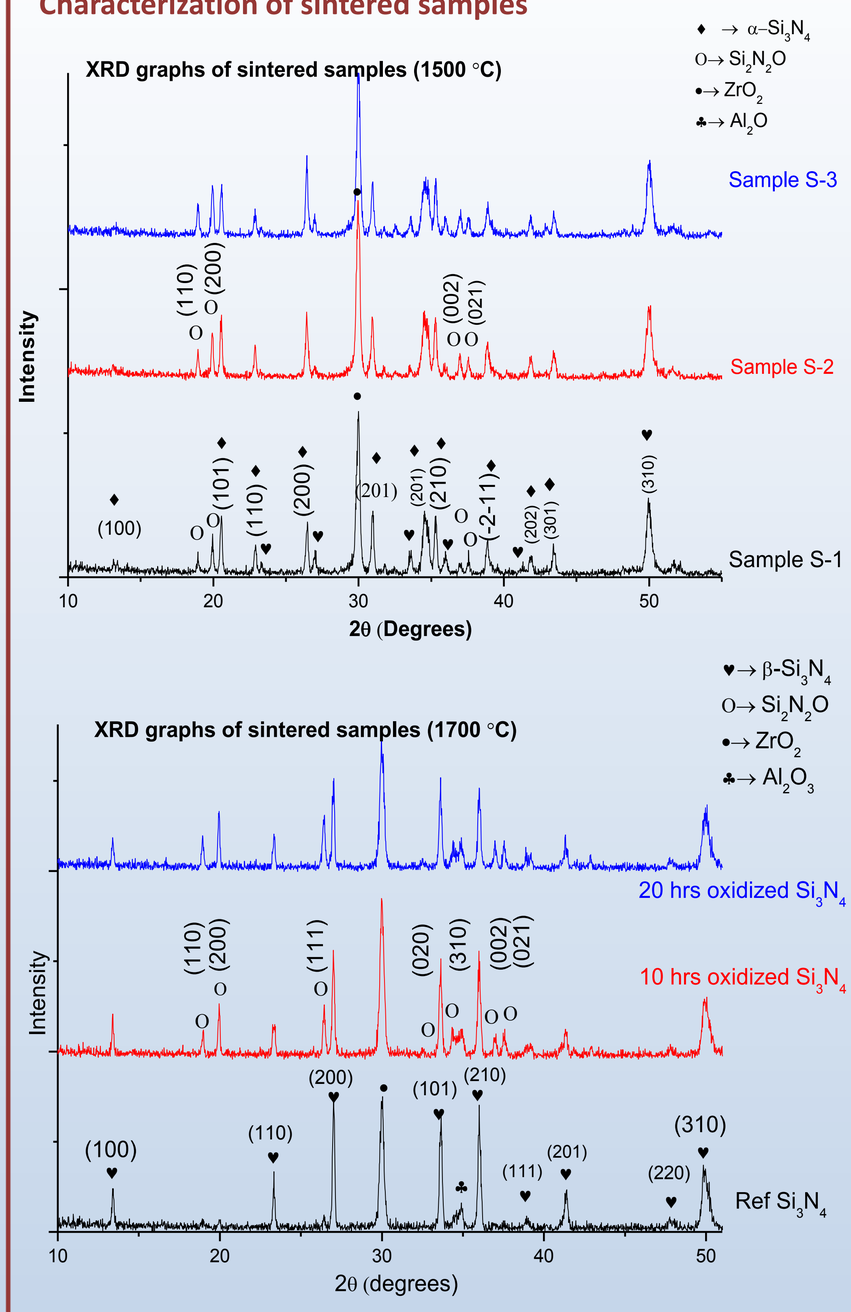


XRD Graphs of Reference , 10 & 20 hrs oxidized powders.



HRTEM images of Si_3N_4 powders a) Reference; b) 10 hrs oxidized; c) 20 hrs oxidized. The oxidation of powder particles and the thickness of amorphous phase (Silicon oxynitride) on silicon nitride powder particles increases with oxidation time.

Characterization of sintered samples

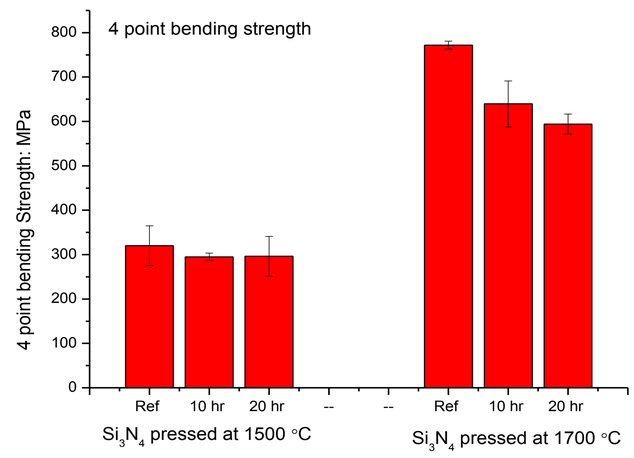


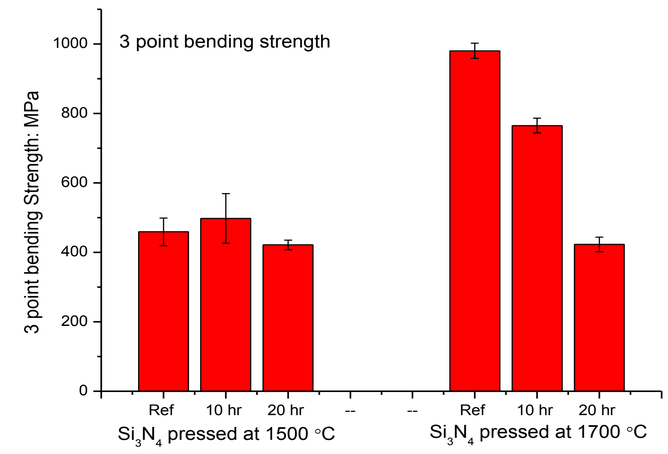
Contact:

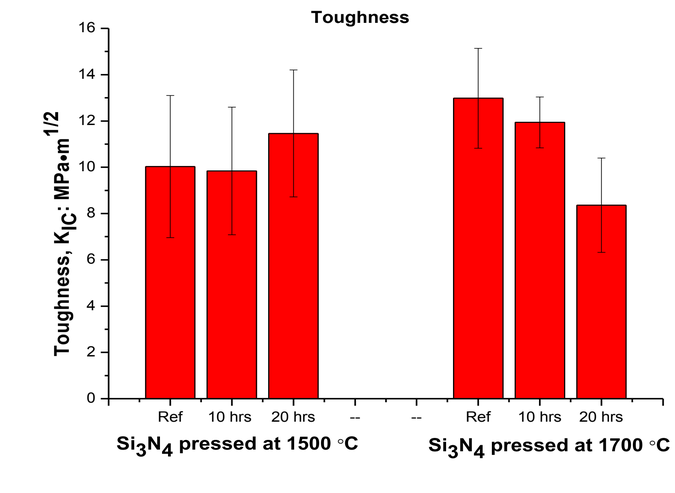
e-mail: awais_qadir980@yahoo.com

Mechanical Properties

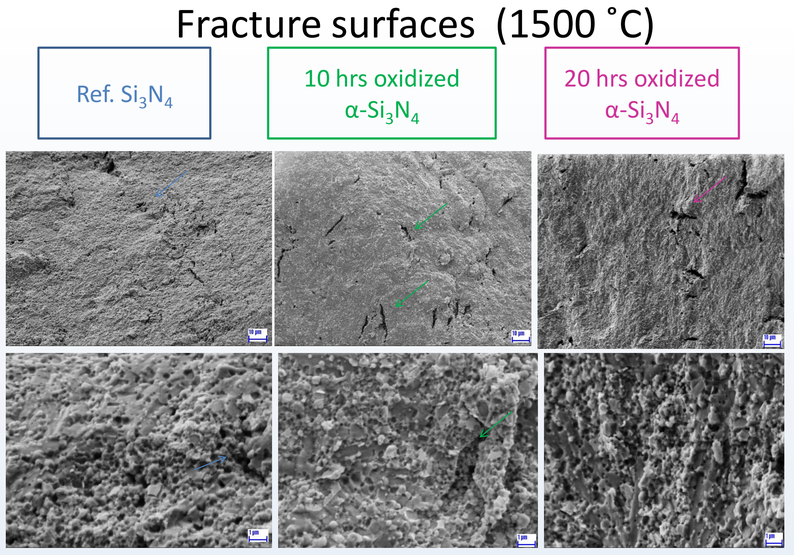
Mechanical Properties



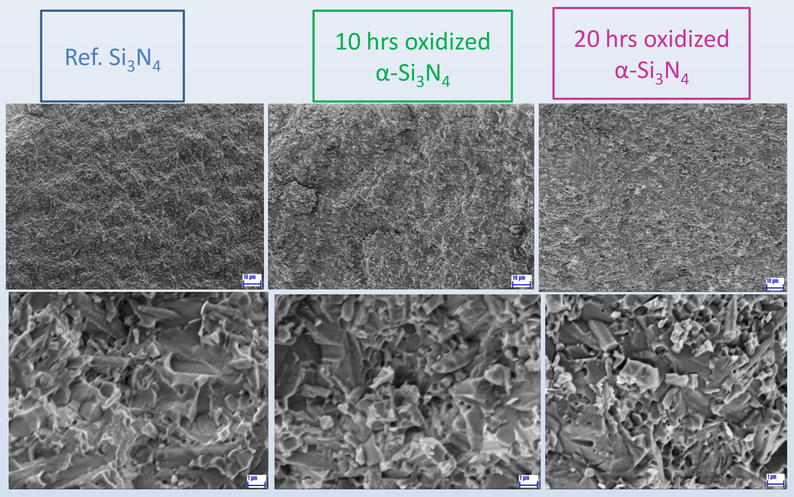




Fracture surfaces (1500 ˚C)



Fracture surfaces (1700 ˚C)



Conclusion

The complete α to β phase transformation was observed at 1700 ˚C. The toughness and strength is higher of those samples which were prepared at 1700 ˚C due to the presence of higher amount of β-phase. The strength and toughness decreased with the oxidation time. Porosity was found in samples which were sintered at 1500 ˚C. The mechanical strength of reference material (sintered at 1700 ˚C) has higher than all of the oxidized samples due to the higher content of β-phase.

References

[1] Gubicza, Jenő, et al. "Mechanical properties of oxidized silicon nitride ceramics." *Mat. Sci. and Engg.A*259.1(1999): 65-72.

[2] M. K. Cinibulk and H.-J. Kleebe, “Effects of oxidation on intergranular phases in silicon nitride ceramics,” *J. Mater. Sci.*, vol. 28, no. 21, pp. 5775–5782, Jan. 1993.