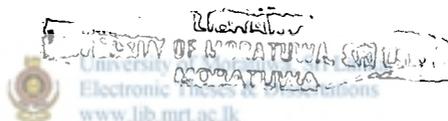


INVESTIGATION ON SINTERING BEHAVIOUR OF WASTE ALUMINA ROLLER MATERIAL IN PRESENCE OF MgO AND ZrO₂

By

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This thesis was submitted to the Department of Materials Engineering University of Moratuwa in partial fulfillment of the requirements for the Degree of M. Sc in Materials Engineering.

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Abstract

In the present study the feasibility of utilization of high alumina roller waste from fast firing kiln was studied. These roller wastes, which contain important quantities of SiO_2 and Al_2O_3 , can be used as cheaply available raw material in ceramic product.

The sinterability of alumina waste powder at 1400°C , 1500°C , 1600°C and 1700°C was studied by density measurement, XRD analysis, microstructural analysis and determination of mechanical properties of those sintered samples. The study was further done by adding ZrO_2 to the waste in different wt% (2-8wt %) and modified with 10wt% alumina powder.

Temperature required for the sintering waste powder to get theoretical density above 95% decreased with the addition of MgO as sintering aid. It showed the addition of MgO in amount above 0.5% promoted densification at 1500°C . At 1600°C , the higher density (~95%) was achieved with addition of MgO in between 0.5% - 1.5%. At higher temperature at 1700°C densification can be achieved with the MgO addition <0.5%. Densification of modified waste with 10% Al_2O_3 was increased with addition of MgO at 1500°C . The maximum density with (99.9%) was obtained at 0.5% MgO.

The XRD patterns of the MgO added waste powder compacts sintered at temperatures up to 1700°C for 3h showed the presence of mullite and corundum as the major phases in all samples. But Mg-Al Spinel was formed when the samples sintered at 1400°C for 3h. Optical microstructure was porous for samples with excess MgO (>1%) sintered above 1600°C for 3h. The SEM observation of the microstructure showed the grain morphology as spherical at 1500°C for 3h, but with increase in sintering temperature to 1600°C for 3h it was observed as elongated rod like grains.

Addition of ZrO_2 acted as sintering aid and above 97% obtained in the sintering temperature range between 1500°C - 1600°C . ZrO_2 addition significantly improved the fracture toughness of the waste powder compacts also.

Better mechanical properties such as hardness and strength were obtained for the densified compacts (above 95%). The maximum hardness was given as 5.35GPaq and

6.13GPa for the compositions 100% waste with 1wt% MgO (96.3%) and modified with 10% Al₂O₃ with 0.5% MgO (99.9%) respectively which were sintered at 1500°C for 3h. Maximum MOR values for the above composition were 169.3MPa and 213.25MPa respectively.



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CONTENTS

	Page No
Acknowledgements	i
Abstract	ii
Contents	iii
List of Tables	vi
List of Figures	vii

I. INTRODUCTION AND STATEMENT OF THE OBJECTIVE 1

II. LITERATURE SURVEY

Fundamental of Sintering	4
Sintering Of Alumina Based Ceramics	10
Factors govern the sintering process	11
Role of MgO in sintering of alumina based ceramics	16
Properties	19
Zirconia Toughened Mullite/Alumina	20

III. EXPERIMENTAL PROCEDURE

Materials & Equipment	23
Characterization Techniques Used	23
Powder Preparation	25
Powder Characterization & Composition formulation	25
Composition Making	26
Samples Preparation	27
Density Measurement	28
XRD Analysis	29
Microstructural Evaluation	29
Hardness Measurement	29
Strength Measurement	30
Young's Modulus Measurement	31
Fracture Toughness Measurement	31

IV. RESULTS

I. Sample Identification and Powder Characterization	32
II. Sintering of Waste Powder Compacts – 100% waste	34
a. Density Measurement	34
b. Phases Formed Analysis	38
c. Microstructural analysis	43
Mechanical Properties	
d. Hardness Measurement	51
e. Strength Measurement	52
f. Youngs' Modulus Measurement	53
g. Fracture Toughness Measurement	54
III. Sintering of Powder Compacts – Modified composition with 10% Al₂O₃	55
a. Density Measurement	55
b. Phases Formed Analysis	58
c. Microstructural analysis	59
Mechanical Properties	
d. Hardness Measurement	63
e. Strength Measurement	64
f. Youngs' Modulus Measurement	64
g. Fracture Toughness Measurement	65
IV. Sintering of Waste Powder Compacts – ZrO₂ added	66
a. Density Measurement	66
b. Phases Formed Analysis	68
c. Microstructural analysis	70
Mechanical Properties	
d. Hardness Measurement	70
e. Youngs' Modulus Measurement	72
f. Fracture Toughness Measurement	72

V. DISCUSSION	73
VI. CONCLUSIONS	81
VII. SUGGESTION FOR FUTURE WORK	83
REFERENCES	84

Appendix I

Theoretical Density calculations and Measured Density Values

Appendix II

Microphotographs of Samples



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LIST OF TABLES

Table		Page
1.1	Import statistics detail of the some alumina based products	2
3.1	Composition of the body	26
4.1	Phases presence inn the samples sintered at different temperature with various MgO%	39



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LIST OF FIGURES

Figure	Page	
2.1	Particles arrangement during Initial Stage of Sintering	6
2.2	Model for neck growth formation (X- Neck size; D-particle size	6
2.3	Particles arrangement during Intermediate stage of sintering	7
2.4	Microstructure of Intermediate stage of	7
2.5	Particle Arrangement in the Final Stage of Sintering	7
2.6	Microstructure during the Final Stage of Sintering	7
2.7	Possible pore-grain boundary appearance during intermediate stage of sintering; a-with densification, b-without densification	8
2.8	Microstructure and pore size for the three stages of liquid phase sintering	10
2.9	Hardness Vs average crystal size of 96% alumina body	12
2.10.a	Microstructures of for fine powder by hot pressing for (A) 0.5 (B) 2 (C) 6 h	13
2.10.b	Microstructures of for coarse powder by hot pressing for (A) 0.5 (B) 2 (C) 6 h	13
2.11	Effect of MgO on Grain size/Densification ratio	16
2.12	Effect of MgO on microstructure (A) Undoped (B) MgO doped	16
2.13	Densification rate of alumina with MgO content	17
2.14	Microstructure development at 1600 ⁰ C for 45 h of undoped and MgO doped	17
2.15	Hardness variation with MgO content	19
2.16	Hardness profile across the grain boundary	19
2.17.a	Variation in strength of mullite during sintering with MgO content	19
2.17.b	Variation in shrinkage of mullite during sintering with MgO content	19
3.1	Powder Preparation Route	25
3.2	Vacuum Process of The Samples Before Isostatic Pressing	27
3.3	Illustration of Isostatic Pressing Method	28

3.4	Model of the Bending Tester	30
4.1	XRD pattern of alumina roller waste sample before sintering	32
4.2	Al ₂ O ₃ – SiO ₂ Phase Diagram	32
4.3	Theoretical Densification (Dth%) Vs MgO% of Waste Sintered Samples	34
4.4	Theoretical Densification (dth%) Vs Sintering Temperature of Waste sintered samples	35
4.5	Water Absorption (%) Vs MgO% of Waste Sintered Samples	36
4.6	Apparent Porosity (%) Vs MgO% of Waste Sintered Samples	37
4.7	X – Ray Diffraction Patterns of 100% waste (73% Al ₂ O ₃ and 25% SiO ₂) ceramics with varying amount of MgO% sintered at (a) 1400°C (b) 1500°C (c) 1600°C and (d) 1700°C (3h)	41
4.8	Microstructure of 100% waste powder mixture (1 %MgO) after sintering at 1600°C for 3h	43
4.9	Microstructure of 100% waste powder mixture (2 %MgO) after sintering at 1600°C for 3h	43
4.10	Microstructure of 100% waste powder mixture (3 %MgO) after sintering at 1600°C for 3h	44
4.11	Microstructure of 100% waste powder mixture (0 %MgO) after sintering at 1700°C for 3h	44
4.12	Microstructure of 100% waste powder mixture (1 %MgO) after sintering at 1700°C for 3h	45
4.13	Cross-section of the sample with 2% MgO added sintered at 1700°C for 3h	45
4.14	Microstructure of 100% waste powder mixture (1 %MgO) after sintering at 1600 °C for 3h Mag 20X3.3	47
4.15	Microstructure of 100% waste powder mixture (2%MgO) after sintering at 1600 °C for 3h Mag 20X3.3	47
4.16	Microstructure of 100% waste powder mixture (3%MgO) after sintering at 1600°C for 3h Mag 20X3.3	48
4.17	SEM Microphotograph of 100% Waste powder mixture (1.5% MgO) after sintering at 1500°C for 3h	49

4.18	SEM Microphotograph of 100% Waste powder mixture (1.0% MgO) after sintering at 1600°C for 3h	49
4.19	SEM Microphotograph of 100% Waste powder mixture (1.5% MgO) after sintering at 1500°C for 3h	50
4.20	Hardness Vs MgO% of Waste Sintered Samples	51
4.21	Hardness Vs Temperature of Waste Sintered Samples	52
4.22	Strength Vs MgO% of Waste Sintered Samples	52
4.23	Youngs' Modulus Vs MgO%	53
4.24	Fracture Toughness Vs MgO%	54
4.25	Theoretical Densification (dth%) Vs MgO% of Modified waste sintered Samples	55
4.26	Theoretical Densification (dth %) Vs Temperature of Modified Waste Sintered Samples	55
4.27	Apparent Porosity Vs MgO% of Modified Waste Sintered Samples	56
4.28	Water Absorption Vs MgO% of Modified Waste Sintered Samples	57
4.29	X – Ray Diffraction Patterns of Modified Waste with 10% Al ₂ O ₃ Ceramics with 2 MgO% Sintered at (A) 1400°C (B) 1500°C (C) 1600°C and (D) 1700°C (3h)	58
4.30	Microstructure of Modified waste powder mixture (1 %MgO) after sintering at 1600°C for 3h	59
4.31	Microstructure of Modified waste powder mixture (2 %MgO) after sintering at 1600°C for 3h	59
4.32	Microstructure of Modified waste powder mixture (3 %MgO) after sintering at 1600°C for 3h	60
4.33	Microstructure of Modified waste powder mixture (0 %MgO) after sintering at 1700°C for 3h	60
4.34	Microstructure of Modified waste powder mixture (1 %MgO) after sintering at 1700°C for 3h	61
4.35	SEM Microphotograph of 100% Waste powder mixture (0.5% MgO) after sintering at 1600°C for 3h	62
4.36	SEM Microphotograph of 100% Waste powder mixture (0.5% MgO)	62



	after sintering at 1600°C for 3h	
4.37	Hardness Vs MgO% of Modified Waste Composition	63
4.38	Hardness Vs Temperature	63
4.39	Strength Vs MgO%	64
4.40	Youngs' Modulus Vs MgO%	64
4.41	Fracture Toughness Vs MgO%	65
4.42	Theoretical Densification Vs ZrO ₂ wt%	66
4.43	Theoretical Densification Vs Temperature	66
4.44	Water Absorption Vs ZrO ₂ wt%	67
4.45	Apparent Porosity Vs ZrO ₂ wt%	67
4.46	X – Ray Diffraction Patterns of Waste Ceramics with 5 wt% ZrO ₂ Sintered at (A) 1400°C (B) 1500°C (C) 1600°C and (D) 1700°C (3h)	69
4.47	SEM Microphotograph of 100% Waste Powder Mixture (5% ZrO ₂) after Sintering at 1600°C	70
4.48	Hardness Vs ZrO ₂ wt%	70
4.49	Hardness Vs Temperature	71
4.50	Fracture Toughness Vs Temperature	72
4.51	Youngs' Modulus Vs Temperature	72
5.1	Bulk density Vs Temperature of mullite sintered with different MgO	73
5.2	Al ₂ O ₃ -SiO ₂ -MgO phase diagram	74
5.3	Scheme of Microstructural Modification	77
5.4	Location of the Fracture Origin	78