DEVELOPMENT OF A GLAZED CLAY BODY SUITABLE FOR COOKWARE

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DECLARATION

I certify that this thesis with the title "**Development of a glazed clay body suitable for cookware**" does not incorporate any material previously submitted for a Degree or Diploma in any university and to the best of my knowledge and belief it does not contain any material previously published written or orally communicated by another person except where due reference is made in the text.

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To the best of my knowledge the above particulars are true and correct

Supervisor

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Signature ***UOM Verified Signature***

Date 22-05-2009

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ABSTRACT

This research work describes development of a glazed red clay cookware body with adequate thermal shock resistance. Two red clay deposits were investigated (Malwana and Hambanthota region) which are currently used for pottery industry. X-ray diffraction analysis (XRD), chemical analysis, differential thermal analysis (DTA) and scanning electron microscopic investigation (SEM) were used to determine the clay properties.

Thermal compatibility of red clay and different fritted glazes were investigated using thermal expansion and thermal shock resistance of individual body/glaze components. This investigation revealed that the coefficient of thermal expansion of red clay was lower than all tested glazes. Therefore it was difficult to formulate a suitable glaze to match the red clay body. Quartz was incorporated into red clay to increase the thermal expansion of the body. According to the results, thermal shock resistance decreased with increasing quartz content of the body. The thermal shock resistance and coefficient of thermal expansion of red clay body were investigated with different proportions of quartz as10%, 20%, 30%, 35% and 40% at a firing temperature of $1050^{0}C$ and isothermal holding time 30 minutes. The behaviours of the thermal conductivity, thermal shock resistance and important mechanical properties such as modulus of rupture and modulus of elasticity of each formulated body were studied. The results revealed that thermal conductivity increased with increasing quartz content of the body. Modulus of rupture and modulus of elasticity were decreased with increasing quartz content of the body.

Initially to preserve the red colour appearance of the product, it was decided to use a transparent glaze and three transparent glazes were investigated. Coefficients of thermal expansion of these transparent glazes were theoretically compatible with body composition having a quartz content of 30%. Actual size cookware samples were fabricated and required properties were tested under actual domestic conditions. But they were not successful on direct heating test. Body compositions with 35% and 40% quartz were investigated and they also gave the same results.

Hence it was necessary to develop a body with better thermal shock resistance having low quartz content. For this purpose glaze with low coefficient of thermal expansion was required and a semi matt glaze was selected by partially sacrificing the red colour appearance of the body.

Malwana red clay body with 25% quartz having a coefficient of thermal expansion $60.31x10^{-7}\ K^{-1}$ and thermal shock resistance 0.97 $kJ\ m^{-1}s^{-1}$ and the glazes having coefficient of thermal expansion in the range of (49-51) $x10^{-7}\ K^{-1}$ and thermal shock resistance in the range of (1.10-1.20) $kJ\ m^{-1}s^{-1}$ could be effectively used to manufacture a glazed red clay cookware product.

It can be concluded that a suitable body composition for glazed cookware production could be formulated by incorporating quartz in correct proportion to kaolinitic type red clay.

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LIST OF TERMS, ABBREVIATIONS AND SYMBOLS

θ	Angle of incidence
σ	Modulus of rupture
α	Coefficient of thermal expansion
υ	Poisson's ratio
σ_b	Tension of the body
σ_g	Compression stress of the glaze
δt	Softening point of the glaze
A_b	Cross-sectional area of the body
A_g	Cross-sectional area of the glaze
b	Width of the specimen
C_p	Heat capacity
d	Inter planar spacing
d	Thickness of the specimen
DTA	Differential Thermal Analysis
E	Modulus of Elasticity
F	Applied force
FEM	Finite Element analysis
k	Thermal conductivity
l	Span length
m	Mass of the sample
r	Thickness ratio of the glaze: body
SEM	Scanning Electron Microscope
T	Temperature
TGA	Thermogravimetry analysis
TMA	Thermo mechanical analyzer
W_1	Dry weight
W_2	Wet weight
XRD	X-Ray Diffraction