# DEVELOPING A PROPER NANO MATERIAL TO USE IN CUISINE CLAY POTTERY

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Master of Science (Major Component of Research)

Department of Civil Engineering
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# DECLARATION

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: Date: 05/08/2025

The above candidate has carried out research for the PhD/MPhil/Masters thesis/dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor: Snr Prof. R. U. Halwatura 05 08 2025

Signature of the Supervisor: Date:

Name of Supervisor: Dr. Upanith S. Liyanaarachchi

Signature of the Supervisor: ***UOM Verified Signature*** Date: 05.08.2025

# DEDICATION

This thesis is dedicated to all those who provided unwavering support and encouragement throughout my academic journey. It stands not merely as a scholarly document, but as a testament to the perseverance and dedication applied during one of the most difficult periods of my life. This accomplishment is not solely my own, it is equally a reflection of the compassion, guidance, and solidarity extended by the remarkable individuals who stood by me during this transformative academic endeavor.

This is dedicated to my lovely family for the continuous encouragement towards these achievements. Especially to my loving husband for supporting me in maintaining my morale, for continuing this effort until success and for my parents for the immense support and the consideration given me within this period. Specially I should mention, this is dedicated as a tribute to my late farther who was passed away during this academic period as fulfilling one of his dreams regarding my academic path.

My great teachers, I have met as my supervisors on this research study, Senior Professor R. U. Halwatura and Dr. Upanith S. Liyanarachchi, are offered this thesis as a result of their clever and super guidance with the subject knowledge and humanity.

To my friends and research colleagues, I dedicate this for their inspiration for fulfilling this research positively and successfully.

Finally, I dedicate this thesis for anyone who is interested in research, to courageous people to continue their academic studies effectively and efficiently and to all individuals who support me to be independent in my academic path and my personal life.

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I must share a huge amount of gratitude to my loving husband and the mother who supported me in this academic activity and remember with love and respect my late father who passed away during the mid of this academic period and for his loving consideration gave me until that period.

Finally, I thank everyone who reinforced me in this academic journey to the successful completion.

# ABSTRACT

Clay pottery, originating at dawn in civilization, is a fundamental village industry primarily used as eco-friendly and health safe cookware. Currently, nonstick metal cookware is popular for convenience but poses health risks from toxic compound releasing to food. Despite its traditional use, clay cookware tends to stick food to the inner surface of pottery during cooking, limiting its functionality. Thus, this study aims to develop a proper mineral nano material to improve the nonstick properties of clay cookware, addressing a key industrial gap. Sri Lankan industrial clays, minerals and their physiochemical properties were identified through the primary data and secondary data from an industrial survey and literature review. Using Gaussian Software under computational chemistry, suitable mineral type was identified through molecular modeling and binding energy calculation to combine with the most common clay. The nonstick performance of clay and mineral combination was assessed via binding energy analysis with fat/oil molecules. Red clay is the most used material for cooking pottery, predominantly utilized by small-scale domestic manufacturers. This sector surpasses medium-scale and government supporting units in usage. Male participation is highest compared to female and both gender involvement. BE calculations show Red clay and Apatite combination has the highest stability with the highest negative BE –3177 kcal/mol. Red clay with fats/oils mixtures have negative BEs of –1552, –2142, –2117, and –1522 kcal/mol, indicating strong interactions, while the Red clay and Apatite mixture shows the positive BEs of 3212, 2376, 2450, and 3903 kcal/mol with fat/oils indicating weaker interactions with less stable systems. The Red clay and Apatite blend reduces fat/oil adhesion and enhances nonstick properties by making Apatite is the ideal mineral to collaborate with Red clay to make pottery. When considering the applying of nanotechnology, using nanoscale particles increases binding energy making the Red clay and Apatite system more stable and nonstick.



**Keywords**: Nonstick Cooking Pottery, Clay and Mineral, Computational Chemistry, Binding Energy, Nanotechnology

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# LIST OF ABBREVIATIONS

| Abbreviation | Description |
|---|---|
| BE | Binding Energy |
| GS | Gaussian Software |
| AU | Atomic Unit |
| PTFE | Teflon, Poly Tetra Fluoro Ethylene |
| PFC | Poly Fluoro Carbon |
| IARC | The International Agency for Research on Cancer |
| PFOA | Perfluorooctanoic acid |
| kcal/mol | kilocalorie per mole |
| ICP device | Inductively Coupled Plasma device |
| PFOA | Perfluorooctanoic acid |
| PFOS | Perfluoro Octane Sulfonate |
| PFAS | Per- and polyfluoroalkyl substances |
| HFPO | Hexafluoropropylene oxide |
| PFBS | Perfluorobutane Sulfonic acid |
| EPA | United States Environmental Protection Agency |
| GDP | Gross Domestic Product |
| NMR spectra | Nuclear magnetic resonance spectra |
| CD spectra | Circular Dichroism spectra |
| IR spectra | Infrared spectra |
| DFT | Density Functional Theory |
| MD | Molecular Dynamics |
| MM | Molecular Mechanics |
| GNM | Gaussian Network Model |
| PBC | Periodic Boundary Conditions |
| E | Energy |
| Opt + Freq | Geometry optimization and Frequency calculation |

# LIST OF APPENDICES