Exhibition

Materiality

Investigative Approach on Experimental Technology, Ceramic Making and Artistic Practice

Cover image: Scanning Electron Microscope (SEM) image, Kaolin + GO + Sonication

Curator
Karen Lim

Institute for Functional Intelligent Materials (I-FIM)
Professor Kostya Novoselov
Associate Professor Daria Andreeva-Baeumler
Graduate Student Wu Jiqiang

Artist
Delia Prvacki

Designer
Clarissa Edeline Yu
Chua Pei Shyuen

Interns
Binali Manilka Pilapitiya De Alwis
Khoh Zhi Wei

Videographer
Zhang Weijin

Printer
Allegro Print Pte Ltd

Exhibition and publication printed in May 2023

ISBN: 978-981-18-7178-8

NUS MUSEUM

NUS National University of Singapore

The exhibition ***Materiality – Investigative Approach on Experimental Technology, Ceramic Making and Artistic Practice*** is the inaugural Artist-in-Residence commission, a new program developed as part of the NUS Public Art Initiative, bringing together artists and the NUS community in interdisciplinary learning. This exhibition presents collaborations between disciplines—invited artist Delia Prvacki, Nobel prize winning physicist Professor Kostya Novoselov, Associate Professor Daria Andreeva-Baeumler, graduate student Wu Jiqiang from the Materials Science Engineering, College of Design and Engineering and Karen Lim, curator of NUS Baba House and Public Art, supported by the NUS Public Art Committee from the Office of President.

Materiality – Investigative Approach on Experimental Technology, Ceramic Making and Artistic Practice

by Karen Lim

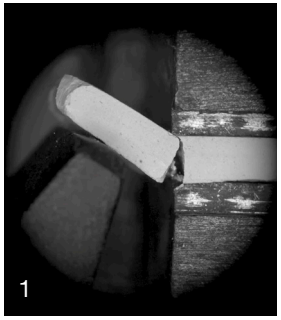
The National University of Singapore (NUS) has established a public art policy towards a university public art collection in 2021. Integrating public art into the campus landscape and architecture connecting us beyond our internal work and social spaces. The collection reflects the diversity and cultural richness of the university, improving the quality and design of spaces, expressing our shared identity, ownership and pride in the community and provides placemaking. Public Art also paves the way for our university community's wellbeing to connect, bond and belong.

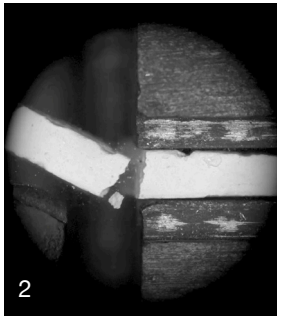
The Artist-in-Residence (AiR) curatorial program is conceptualised and developed as one of the en suite of public art initiative, providing a platform for interdisciplinary learning. A customized program in partnership with host faculty, where community engagement is key. Students, staff and artist have a chance to converse and understand each discipline's creative thinking, processes and outcomes. It provides critical perspectives and partnering students in holistic discovery. The exchange allows powerful synergies and connects opportunities across education, research, innovation and enterprise.

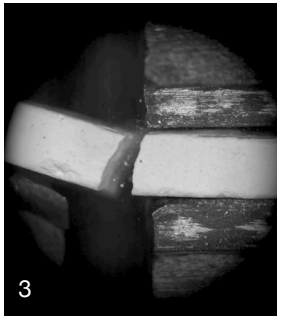
By the agency of AiR, the exhibition ***Materiality – Investigative Approach on Experimental Technology, Ceramic Making and Artistic Practice*** is birthed. This exhibition examines the innovation of ceramic medium using technology and demonstrates the interdisciplinary commitment and rigor between artist, materials scientists and curator investigating, developing and communicating on materiality. The collaborative approach provides insights into the reciprocal and integral processes of research and development in the physical and engineering sciences of the material—novel application of graphene oxide (GO) with kaolin (clay)—aimed at meeting performance requirements in its properties and mechanical strength for use in public art making and the construction industry in the future. The documentation concurrently demonstrates the characteristics of the medium, ceramic making—from raw material to the finished object in relation to artist, Delia Prvacki's practice and intent.

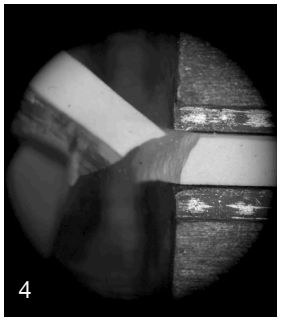
Materiality is curatorially positioned at the archival square of the Lee Kong Chian Gallery at the NUS Museum, in context where archeology, Southeast Asian sherds, Chinese and Straits Chinese ceramics collections are displayed. Allowing the understanding of these interdisciplinary connections and material shifts between periods, geographies and cultures. It offers new meanings on the act of seeing, the study of art history, conservation, preservation, archaeology, anthropology, culture and science; opening new avenues of investigation on art objects, to comparative inquiries that cross traditional boundaries between disciplines, genre, time and space. The combination of these disciplines presents a new language in science, engineering, art and culture; the interdependence of scientific research, technical developments of scientist and artist, coupled by the interdisciplinary endeavor with societal needs. This dichotomy and connections of engagement reflect the desire of how materials can be utilized and advanced, finding ways to employ existing raw materials more efficiently and to better our community and civilization.

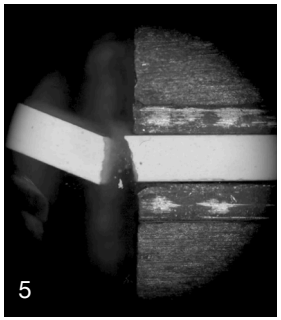
The act of seeing is an important tool and practice in varied disciplines. Seeing allows us to appreciate more in depth understanding on materiality; kaolin is used as a signifier—to investigate, innovate and appreciate the structure and aesthetic quality as object and art practice. The scientific understanding of the material also helps in preventive measures of inquiry, technical and aesthetic considerations in conservation of ceramics. While firing temperatures determine the strength of ceramic, the construction of the material in this experiment also have an impact on the strength, fragility and preservation of ceramics. The task of understanding properties and how each material behaves in the six kaolin compounds are tested for destruction presented in these six high-speed videos in the gallery: 1. Tile with no fire; 2. Tile fired at 900°C; 3. Tile fired at 1204°C; 4. Tile with GO fired at 1204°C; 5. Tile with sonication fired at 1204°C; and 6. Tile with GO and sonication fired at 1204°C.

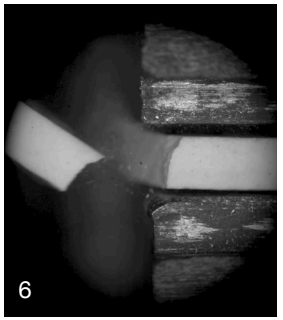












Video stills from I-FIM:

1. *Tile with no fire*
2. *Tile fired at 900°C*
3. *Tile fired at 1204°C*
4. *Tile with GO fired at 1204°C*
5. *Tile with sonication fired at 1204°C*
6. *Tile with GO and sonication fired at 1204°C*

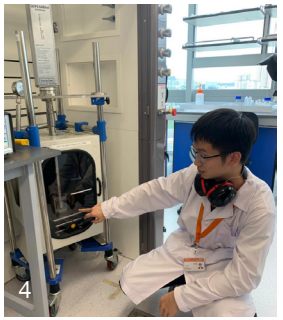
Videos 1 and 2 show unfired and low fired tiles, at risk of rehydration because they are porous and not vitrified. Young's moduli of such materials are below 4 GPa. The higher the temperature at which the tiles are fired, kaolin material physically changes, the lower the porosity and the more vitrified they become. Young's moduli of such materials exceed 4 GPa. In the 6th video, tile with GO and the use of sonication fired at 1204°C, shows the improvement of mechanical properties when the tile is put to test. The smallest fragments, evenly distributed with the least flakes, can be seen in the outcome of the test method. Young's moduli of such materials are above 10 GPa.

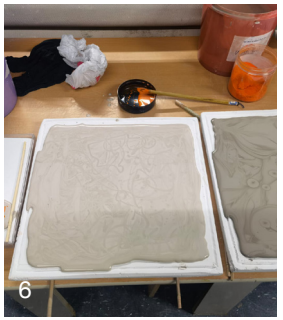
Artistic Practice

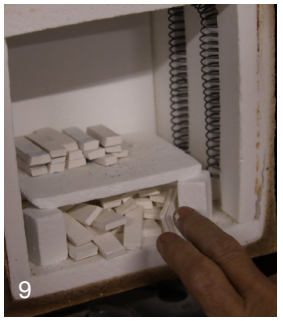
Giving life to kaolin or clay and transforming it into artworks have been 50 years of Delia's art practice. Kaolin besides an art medium, is deeply connected to Delia's autobiography, where her birth country, Romania is known for its history of pottery in ceramic industry. Delia's extensive knowledge, ceramic craftmanship and experience working with kaolin is unrivalled. For her, the discipline of making ceramic tiles is akin to sketching and journaling her thoughts. Following the rules of composition like a painter, exploring different possible textures, effects and finishes on what the material can offer, these repetitive form of ritualistic practice and experimentation is part of her artistic process. Considerations and interactions with the material are made by artist based on different kaolin, different consistency of material, different humidity levels in the air and the availability of artist's time. The tools that are principally used are her fingers, scraper, brushes, clipper, moulds, soft rags and clay tools for design and modelling. From there, the tiles Delia produced are catalogued neatly into colour groupings by the artist, where they are further used into the making of mosaic tiles, murals, and artworks.

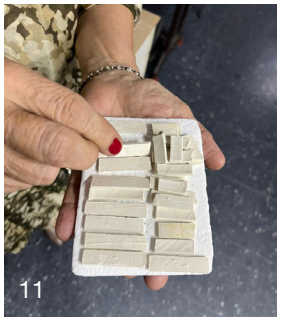
In this collaboration, the trajectory of practice and research takes Delia through several iterations of creation and evaluation similar to materials scientist: from initiating the research collaboration of testing GO into kaolin, to collaboratively analysing each sample of kaolin GO compounds, pouring compounds into moulds to form tiles, drying, cutting and firing, further testing by Jiqiang in the laboratory, and the creation of more new tiles using the tested and modified strategy, and ultimately capitalising on the properties of the new material to create new artworks.

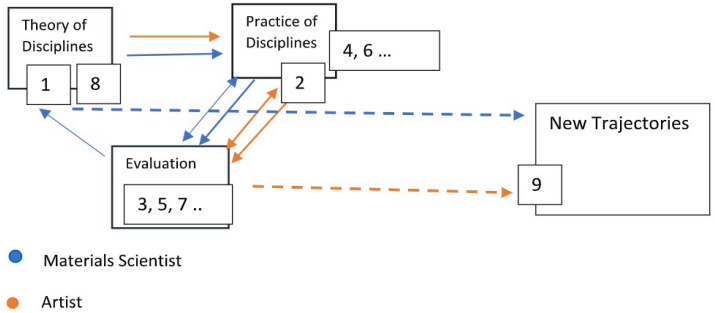
Photo Documentation







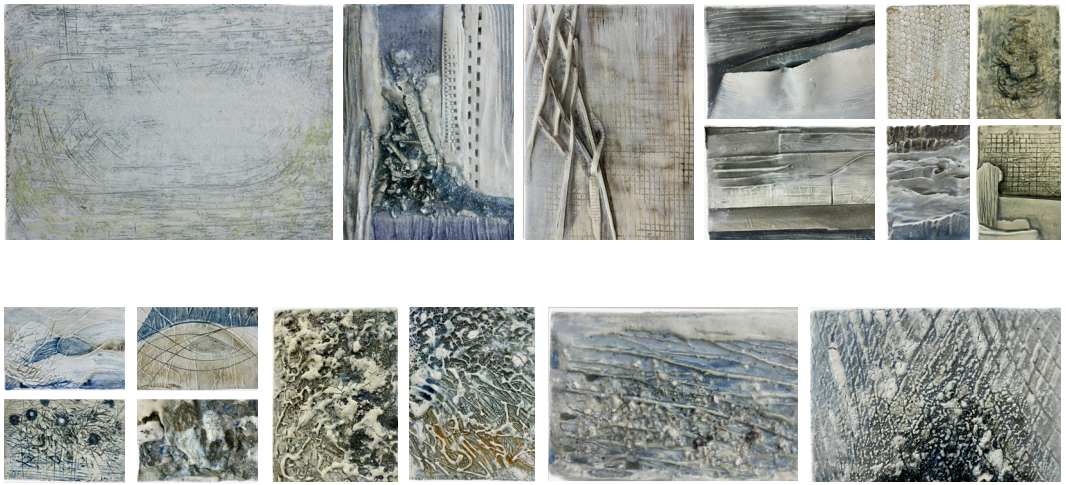




The photo documentation on the collaborative process and the above diagram illustrate the creative methodology for both materials scientist and artist are synonymous. It shows that art making and innovation is not by chance, it is methodical and is based on technical principles.

Along with this collaborative experiment, Delia tested the medium through artistic methods of discipline entrenching ceramic art making more firmly in its area of competence. With years of experience with her hands, by touching the new kaolin mixture she is able to tell that the experiment of kaolin with GO and sonication has the best material properties. Just as materials scientists and engineers are interested in the microstructure of materials, as the arrangement of atoms and molecules will make an impact on macroscale properties of materials, Delia using her own language created a new series of works entitled *Macro to Micro* in two-dimensional ceramic tile paintings and three-dimensional sculptural studies.

Each ceramic tile, handmade and tactile, are like miniature paintings, built and decorated by its new material with the application of colours. These ceramic paintings can be studied based on a variety of elements in its sensory, material properties and form; such as, line, colour, brushwork, style and composition. Each created in a certain order, intrigued with existential questions of the universe, and understanding that life around us is full of three-dimensional geometry. The ceramic paintings created are in formalistic rectangular shapes expressing the universal system of measurements in the geometry of perfect proportions. For example: A3 size paper folded into half, consists of two A4 size sheets; A4 size consists of two A5 size sheets; A5 size consists of two A6 size sheets and so forth. In order to explore proportion, the series reveal that everything connects to everything else. These folding properties are interesting as the shapes of all these are exactly the same shape, just different sizes of the same shape; thereby characterising those shapes. To articulate further on artist's intent of these series, integrating concepts and ideas, the paintings are displayed based on the theory of The Golden Ratio.



The sculptural studies are inspired from the perception of seeing ceramic as a tangible (macro) object and with the aid of scanning electron microscope (SEM) technology, one can see the inside of ceramic material in its intangible (micro) form. Textural quality of these sculptures is created by carving using sculpting tools, smoothing with toothbrush and burnishing using soft cloth after bisque firing. Slips with GO are also added at times. As much as Delia's practice is methodical and controlled, the result on the colour and surface finish in all her works are left to chance in the kiln firing.

The making and building of objects around us are akin in the practice of artists and materials scientists. The exhibition reflects the importance of interdisciplinary collaboration and highlights the intersection between disciplines, offering alternatives of seeing. The relationships between the structure of a material and its properties, the material as a form from natural (kaolin) to a new material (kaolin with GO and sonication), and how the form evolves in the hands of an artist, and through firing, the properties of the form changes internally and externally resulting in the surface and colour achieved by chance. Additionally, it gives a more complete picture of the varied hands, voices, perspectives, histories and legacies that are involved in an object, what it represents and the wide opportunities for further studies on the ceramic collections at the NUS Museum. These inquiries raise questions about production, reception, consumption and intention along with social, ideological, philosophical and economical aspects such as trade, value, and the significance to the global ceramic manufacturing, mechanical and construction industries in the future.

Extra spread (space for one picture)

Glossary

Crack Morphology

Crack morphology is a very important metric to consider when studying a material's mechanical properties and compatibility. It is studied using SEM images. With these images, we can infer how material fractures. In our experiment, when the material's surface looks powdery, it indicates suspected fractures in the future. When more smooth surfaces are revealed in the SEM image, it confirms that the components in our composite materials are well integrated and the material is mechanically stable.

Golden Ratio

The Golden Ratio, first mentioned in Euclid's Elements in 300 BCE, is a mathematically pleasing proportion observed in nature, art, and architecture. During the Renaissance, it became a hallmark of artistic style, explored by mathematician Luca Pacioli and illustrated by Leonardo da Vinci in "The Vitruvian Man". Today, it remains a popular inspiration for creating aesthetically balanced compositions.

Graphene

Graphene has emerged as one of the most promising nanomaterials because of its unique combination of exceptional properties. It is one of the strongest and thinnest materials and an excellent conductor of heat and electricity.

Graphene Oxide (GO)

The key difference between graphene and graphene oxide (GO) is that the latter is the oxidized form of graphene that is compatible with other materials. GO is a useful and promising compound for the formation of graphene-based composites for applications in electronics, optics, robotics, energy, medicine, architecture, and others.

High-Intensity Ultrasonication (HIUS)

High-intensity ultrasonication (HIUS) is a method of applying sound energy to create novel materials and structures. The process involves fragmentation, redistribution and mixing of materials. In our experiment, the HIUS is used to disperse graphene oxide particles in kaolin matrix to form novel composite materials.

Kaolin

Kaolin is a fine white clay, also known as china clay, used for manufacturing porcelain and bone china.

Scanning Electron Microscope (SEM)

SEM is a microscope that uses electrons instead of light to produce an image. The electrons interact with atoms in the sample, producing various signals that contain information about the surface topography and composition of the sample with magnification au to 3,000,000 times.

Sintering

Sintering is a thermal process of converting loose fine particles into a solid coherent mass by applying heat, and/or pressure without fully melting the particles.

Thermal Gravimetric Analysis (TGA)

Thermal Gravimetric Analysis is a method of thermal analysis in which the mass of a substance is measured over time as temperature changes. In our experiment, TGA allows us to prove the composition of our novel composite materials.

Young's Modulus

Young's modulus measures material's stability. It tells us how much a material will deform when a force is applied. When Young's modulus is high, the more stable the material and the lesser it will deform under a given force. It is an important concept in MSE for designing structures and predicting how they will behave under different types of loads and stresses. Materials that are considered stable such as metals and ceramics, have Young's moduli in the range of tens to hundreds of gigapascals (GPa).

Acknowledgements

The NUS Museum would like to express their sincere gratitude to the following individuals and departments for their support and interest in the exhibition and publication of ***Materiality – Investigative Approach on Experimental Technology, Ceramic Making and Artistic Practice***, a NUS Public Art Initiative.

Public Art Committee (Mar 2021–Mar 2023)
Professor Ho Puay Peng, Koh Yan Leng, Professor Rajeev Patke, Associate Professor Kua Harn Wei, Dr Suriani Suratman Sharon Tan, Ahmad Mashadi, Randy Chan and Debbie Ding.

College of Design and Engineering
Professor Aaron Thean, Deputy President (Academic Affairs) and Provost. (Past Dean)

NUS Institute for Functional Intelligent Materials
Professor Kostya Novoselov, Associate Professor Daria Andreeva-Baeumler and graduate student Wu Jiqiang.
Maxim Trubianov, Denis Bandurin, Magdalena Grzeszczyk and Marilen Buenviaje for helping with the experimental set-ups.

Artists
Delia Prvacki and Milenko Prvacki.

Assistants and Students
Binali Manilka Pilapitiya De Alwis, Clarissa Edeline Yu, Chua Pei Shyuen and Khoh Zhi Wei.

NUS Museum
Anisah Begum d/o Syed Ibraham, Chng Pei Ling, Devika d/o Murugaya, Evelyn Lim, Mao Zhongcheng, Mo Kang Ho, Nur' Amalina Jamaludin and Jonathan Tan.

NUS Libraries
Marcus Wong and Nur Azzahra Binte Kamal.

NUS Public Art Initiative