THE CERAMIC PLATE "PURPLE SET NO.1-4" FROM SILPAKORN ART CENTRE CONSERVATION OF THE CERAMIC PLATE AND TESTING OF VARIOUS ADHESIVES FOR CERAMIC BONDING IN SOUTHEAST ASIA

By
Mr. Khanh Nguyen QUANG

An Independent Study Submitted in Partial Fulfillment of the Requirements
for Master of Arts CULTURAL HERITAGE CONSERVATION AND MANAGEMENT
Silpakorn University
Academic Year 2023

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Mr.Khanh Nguyen Quang

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By	Mr. Khanh Nguyen QUANG
Field of Study	CULTURAL HERITAGE CONSERVATION AND MANAGEMENT
Advisor	Dr. Thanya Lunchaprasith

Faculty of International College, Silpakorn University in Partial Fulfillment of the Requirements for the Master of Arts

.... Dean of Faculty of International College
(Assistant Professor Dr. Sompid KATTIYAPIKUL)

Approved by

.... Chair person
(Dr. TATJANA BAYEROVA)

.... Advisor
(Dr. Thanya Lunchaprasith)

.... Committee
(Dr. Nethchanok Riddhagni)

.... External Examiner
(Professor Dr. Gabriela Krist)

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Mr. Khanh Nguyen QUANG : The Ceramic Plate "Purple Set No.1-4" from Silpakorn Art Centre Conservation of the Ceramic Plate and Testing of Various Adhesives for Ceramic Bonding in Southeast Asia Thesis advisor : Dr. Thanya Lunchaprasith

THE CERAMIC PLATE “PURPLE SET NO. 1 - 4” FROM SILPAKORN UNIVERSITY ART CENTER, BANGKOK, THAILAND

Conservation the Ceramic Plate and Testing of Various Adhesives for Ceramic Bonding in Southeast Asia

This thesis focuses on conserving the ceramic plate, "Purple Set No.1 – 4", owned by Silpakorn University Art Center. Investigation and study highlight the crucial aspect of preserving ceramic objects and emphasise the significance of selecting appropriate adhesives for bonding broken ceramics. The research aims to investigate and document relevant information regarding the origin of the fractured ceramic. It involves conducting a series of test experiments to evaluate suitable adhesive options for each type of material, and evaluate the effectiveness of different adhesive types for ceramic materials. The analysis examines the constituents of ceramic conservation adhesives, including natural and synthetic variants. This thesis also initiates the development of a concept regarding selecting appropriate adhesives for ceramic bonding in the Southeast Asian region. Choosing the correct adhesive for each ceramic material is essential for achieving effective conservation outcomes.

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Supervision

o.Univ.-Prof. Mag. Dr. Gabriela Krist

Dr. Thanya Lunchaprasith

Silpakorn University International College, Silpakorn University

Co-supervision Conservation

Mag. Paul Schubert, conservator and teacher

Silpakorn University International College, Silpakorn University

Institute of Conservation, University of Applied Arts Vienna

Univ.-Ass. Mag. Elias Campidell

Institute of Conservation, University of Applied Arts Vienna

formerly, conservator and teacher

Silpakorn University International College, Silpakorn University

Univ.-Ass. Mag. Franziska Marinovic

Institute of Conservation, University of Applied Arts Vienna

Univ.-Ass. Dr. Tanushree Gupta

Institute of Conservation, University of Applied Arts Vienna

Co-supervision Natural Sciences

VL Dipl.-Ing. Dr.rer.nat. Tatjana Bayerová

Institute of Conservation, University of Applied Arts Vienna

Commissioning Entity

Khanh Nguyen QUANG

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Introduction

This study conserves and restores the ceramic plate titled "Purple Set No.1 - 4" from the Silpakorn University Art Center. It presents the importance of selecting suitable adhesive materials for ceramic restoration, specifically emphasising maintaining cultural heritage values. The research includes evaluations of different adhesive types, their bonding strength, durability, and aesthetic qualities when applied to ceramic materials like terracotta, earthenware, stoneware, and porcelain.

The study proposes implementing a test series designed explicitly for gluing ceramic objects. This series aims to investigate and document the characteristics and properties of different adhesive types used in ceramic restoration. The ultimate goal is to identify the most appropriate adhesive for bonding the ceramic plate “Purple Set No.1 - 4" based on its material and condition.

Furthermore, the research comprehensively discusses various adhesive options for ceramic restoration, including natural and synthetic adhesives. It covers the original components of these glues and their implications for the longevity and preservation of ceramic objects. The importance of selecting a suitable adhesive for successful repairs and conserving broken ceramic pieces is emphasised. Additionally, it addresses the proper storage and display of ceramic objects, recognising their significant impact on the longevity and preservation of these precious artefacts.

In conclusion, the work examines the conservation and restoration of the "Purple Set No.1 - 4" ceramic plate, including cleaning, filling, retouching, and restoration, as well as other associated measures that have been carried out, highlighting the importance of adhesive selection. Before applying the appropriate adhesive for conserving the "Purple Set No.1 - 4" ceramic plate, it proposes a test series for evaluating adhesive characteristics, comprehensively discusses different adhesive types, and addresses the proper storage and display of ceramic objects. The research aims to contribute practical insights for ceramic restoration professionals worldwide, focusing on preserving cultural heritage in the Southeast Asian region.

1. The ceramic plate "Purple set No.1-4" from Silpakorn University Art Center

Inv. Nr.	1986/01
Artist:	Preecha Amomrat (1945 – 2004)
Purple set No.1-4/ description:	The collection known as "Purple set No.1-4" comprises four plates, and the specific plate in need of conservation is labeled as No.1 in the inventory. This ceramic plate, exhibiting a large shard and crumbled pieces, requires conservation and restoration to prevent further deterioration. The plate also has visible damages, including a loss, missing glaze, and dust on both sides.
Technique:	This ceramic plate, crafted by hand, features a stone ceramic composition. It is burned at a high temperature of 1250 degrees, resulting in a sturdy structure. The plate is adorned with colorful glazes on the top side and a single black glaze on the bottom.
Dimensions:	The plate has a diameter of 37 cm, a height of 6 cm, and a depth of 5 mm.
Dating:	1986
Owner:	Silpakorn University Art Center

Figure 2 : Front side of the plate

Figure 1 : Back side of the plate

1.1. Description

The plate has a circular shape and dimensions of 37 cm in diameter and 6 cm in height, it stands out for its artistic and technical qualities.

On the front side, the plate features a low rim and a shallow interior, providing a generous surface area for displaying vibrant colors and intricate decorations. The artistic patterns, consisting of shades of blue, ivory white, purple, and reddish-brown, are enhanced by the addition of white. However, careful observation reveals the presence of small holes, likely a result of the firing process, indicating the occurrence of bubbles.

The back of the plate is coated with silk-mat black glaze, creating a visually appealing effect. The base of the plate features a low foot without glaze.

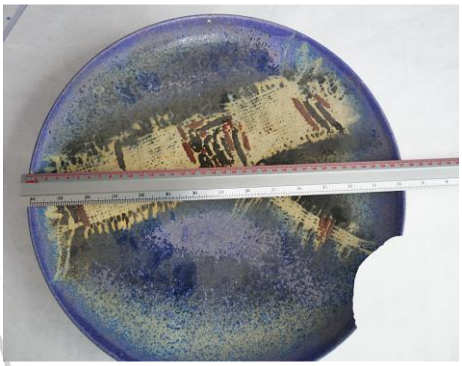

Figure 3 : The plate’s diameter 37 cm.

The patterns decorating the surface of the plate convey a captivating meditation theme. For the glazing process, a technique involving the use of fabric to create patterns, inspired by meditation themes, could be employed. These patterns offer a tactile experience, evoking a sense of roughness and texture. The incorporation of dotted details within the design adds to the plate's enigmatic symbolism, inviting viewers to contemplate its deeper meaning and significance.

Flipping the plate over, the underside reveals a consistent and uniform coating of black glaze, providing a striking contrast to the vibrant colors on the front side. The glaze covers the entire back surface, emphasizing the overall aesthetic coherence of the plate.

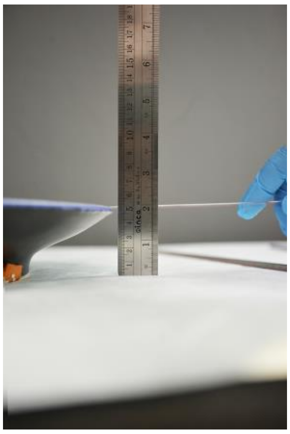

Figure 4 : The height of the plate 6 cm.

The base of the plate also deserves attention. The unglazed base, measuring 6 mm in height (Fig.4) and nearly 5 mm in width, displays a ceramic texture that allows the natural material to shine through.

What distinguishes the base even further is an intriguing detail—carved into the foot of the base is carved pattern that bears a resemblance to the number 86.

1.2. Preecha Amornrat[1]

Preecha Amornrat (1945 - 2004) was a renowned Thai artist, known for his vibrant paintings that showcase the beauty and culture of Thailand. Born in Bangkok, Preecha studied at Silpakorn University, one of Thailand leading art universities, where he developed a unique style. That would later make him famous. His career encompassed a diverse range of artistic mediums, beginning with painting and later extending into the field of ceramics.

Preecha initially gained recognition for his paintings, which served as captivating visual narratives that represented the beauty and cultural essence of Thailand. Drawing inspiration from the country’s rich artistic heritage, he delved into the intricacies of Thai textiles and the exquisite woodcarvings adorning ancient temples. Through his artwork, Preecha sought to honor and celebrate Thailand’s profound history and cultural legacy.

In the 1980s, driven by an insatiable curiosity and an urge to explore new creative avenues, Preecha embarked on a transformative journey into the world of ceramics. This marked a pivotal turning point in his artistic development, as he sought to transcend the boundaries of painting and delve into the realm of three-dimensional art. By venturing into ceramics, Preecha aimed to merge his expertise in painting with the tactile and sculptural qualities of clay, opening endless possibilities for artistic expression.

The shift to ceramics allowed Preecha to experiment with novel materials, textures, and forms, resulting in an exciting fusion of painting and sculptural elements. Through his mastery of the medium, Preecha was able to breath life into his ceramic creations, capturing the essence of everyday Thai life, bustling street scenes, exuberant festivals, and captivating mythological tales.

Beyond his artistic endeavors, Preecha was also a devoted educator, sharing his wealth of knowledge and passion for the arts with aspiring talents at Silpakorn University. His role as a teacher provided him with the opportunity to inspire and mentor young artists, leaving an enduring impact on the next generation of creative minds.

[1] Smith, P. (2010). Preecha Amornrat: Art and Life in Thailand. Singapore: Editions Didier Millet.

Preecha's contributions to the art world extended beyond his own artistic practice. He was a prolific writer and contributed extensively to art publications, sharing his insights, experiences, and artistic philosophies. His writings served as a source of inspiration and guidance for fellow artists, fostering a sense of artistic community and collective growth.

Preecha's artistic achievements and influence spanned international borders, as his works were showcased in galleries and museums around the world. From Thailand to Japan, France to the United States, his exhibitions captivated audiences and garnered critical acclaim. He is widely considered one of Thailand's most important modern artists, with a lasting legacy that continues to inspire and resonate with artists and art enthusiasts alike, both within his homeland and beyond.[2]

Given Preecha Amornrat's diverse accomplishments in the field of art, the collection of ceramic art is considered a shining success in his creative journey beyond painting. This collection of plates was awarded a bronze medal at an art exhibition in 1986, acknowledging Preecha Amornrat's achievements. Silpakorn University has since collected and preserved these plates at its Art center.

1.3. The Art Centre of Silpakorn University

The Art Centre of Silpakorn University is an organization dedicated to promoting contemporary art through national and international art exhibitions and activities held at various venues beyond its own spaces.

The Silpakorn University Art Centre, established in 1979, is a historical institution located within two former royal buildings: the Grand Hall and the Pannarai Wing, which were originally part of the Wang Thapra palace, also known as the West Palace.[3] The West Palace was built during the reign of King Rama I when Bangkok became the capital city. Later, King Rama II granted the West Palace to Prince Jetsadabodin (who would later become King Rama III) and his descendants. In the reign of King Rama V, the palace building was given to Prince Narisara Nuvativongse as his residence. In 1943, Silpakorn University was established, and shortly after that, the West Palace was

[2] Smith, P. (2010). Preecha Amornrat: Art and Life in Thailand. Singapore: Editions Didier Millet.

[3] http://www.art-centre.su.ac.th/art-centre-history.html

closed down. In 1960, Silpakorn University obtained royal permission from Prince Narisara Nuvativongse's descendants to utilize the palace building and its compound as a university. In 1979, the Art Centre was established within these royal buildings, comprising the Main Hall, the Grand Hall, and the Pannarai Wing.

The Art Centre aims to promote and disseminate knowledge and information about contemporary art. It regularly organizes international collaborations and exchange projects related to art and culture. As Thailand's most prestigious art gallery, located at the heart of the campus, it hosts art exhibitions and similar activities year-round, including three major national events: the National Art Exhibition, the Exhibition of Contemporary Art by Young Artists, and the National Ceramic Art Exhibition.

The Art Centre's exhibitions feature diverse artistic mediums, including paintings, sculptures, ceramics, and more. Its extensive ceramic art collection highlights the significance of this art form within the overall exhibition. By showcasing a variety of art forms and engaging in cultural exchange, the Art Centre plays a crucial role in fostering appreciation for contemporary art and preserving the rich artistic heritage of Thailand.

In conclusion, the Art Centre of Silpakorn University serves as a platform for the promotion, education, and celebration of contemporary art. With its gallery spaces, rich history, and diverse exhibitions, it continues to contribute to the cultural landscape of Thailand and inspire both local and international artists and art enthusiasts.[4]

[4]*The content has been compiled and translated from the Thai language using the website. http://www.art-centre.su.ac.th/*

2. Technological survey

2.1. Ceramic body

The term ceramic refers to the raw material or composition used as the base for creating ceramic objects. It is the mixture of various ingredients that forms the foundation of the ceramic product before it undergoes the firing process.[5]

Material analysis may be conducted to understand the composition of the ceramics and assess its susceptibility to environmental factors or potential degradation. This analysis can involve various scientific methods to determine the chemical composition, structure, and potential risks associated with the materials used in the ceramics[6], which cannot be completed within this thesis.

Clay materials are assigned various names based on their distinct characteristics, including color, texture, and workability. Traditional ceramic bodies are commonly named after their primary components, like clay. The composition of clay often involves a blend of clay, and frit in differing proportions. Meanwhile, modern ceramic compositions are often named based on their intended purpose or primary raw material. In the book "Ceramic Bodies," authors Singer, F., and Singer, S.S. (1963), the details of the structure and firing process of ceramic materials are explored. Specifically, this study outlined a range of ceramic types:

Earthenware: A low-temperature ceramic material with high water absorption and a relatively weak structure compared to other ceramic materials. It is typically fired between 800°C to 1100°C (1472°F to 2012°F).

Colored earthenware: Weaker ceramic material with moderate water absorption and a porous structure, offering a variety of colors. It is fired at similar temperatures to earthenware, typically between 800°C to 1100°C (1472°F to 2012°F).

Stoneware: Higher-density ceramic material with increased heat resistance compared to earthenware. It has a stronger structure, better mechanical strength, and durability. Stoneware is typically fired between 1200°C to 1300°C (2192°F to 2372°F). (Singer, F., Singer, S.S. (1963).

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[5] Singer, F., Singer, S.S. (1963). Ceramic Bodies, chapter 5.

[6] Susan Buys, Victoria Oakley.1993. Book: *Conservation and Restoration of Ceramics,*

link: *https://doi.org/10.4324/9780080502892*

Fine stoneware: Refined stoneware used for tableware and artware, featuring a purer composition and a stronger, more reliable structure. It is fired at similar temperatures to stoneware, typically between 1200°C to 1300°C (2192°F to 2372°F).

White earthenware: Porous ceramic material with high water absorption, suitable for a wide range of products. It has a relatively stronger structure compared to other low-temperature ceramic materials. White earthenware is typically fired between 900°C to 1100°C (1652°F to 2012°F).

Thermal shock-resisting stoneware: Stoneware with added special additives to enhance its resistance to thermal shock. It is fired at temperatures similar to stoneware, typically between 1200°C to 1300°C (2192°F to 2372°F).

Electrical stoneware: Stoneware incorporating specific additives for electrical conductivity. It is also fired at similar temperatures to stoneware, typically between 1200°C to 1300°C (2192°F to 2372°F).

Fireclay bodies: Strong ceramic material with moderate porosity, off-white in color, utilizing natural fireclays instead of china clays, ball clays, or stoneware clays found in other bodies. Its open structure allows the production of large, robust pieces. Fireclay bodies are typically fired between 1200°C to 1300°C (2192°F to 2372°F).

White chemical stoneware: Pure ceramic material that requires high-quality raw materials to eliminate contamination. It is also fired at similar temperatures to stoneware, typically between 1200°C to 1300°C (2192°F to 2372°F).

Refractories: High-temperature ceramic materials used in construction, known for their exceptional heat resistance and strong structure. Refractories are fired at elevated temperatures ranging from 1500°C to 1800°C (2732°F to 3272°F) or even higher.

Porcelain: The highest-grade ceramic material, known for its exceptional strength and purity. It exhibits the strongest structure and can withstand the highest temperatures among ceramic materials. Porcelain is fired at temperatures above 1300°C (2372°F) and can reach up to 1400°C to 1600°C (2552°F to 2912°F) or higher.[78]

[7] Singer, F., Singer, S.S. (1963). Ceramic Bodies, chapter 5.

The classification of the plate as porcelain is substantiated by a thorough examination of its ceramic body. This analysis adheres to specific criteria, including the predominant presence of clay minerals such as kaolin, ball clay, or fire clay in the ceramic composition. Furthermore, the plate undergoes firing at exceptionally high temperatures, typically exceeding 1300°C (2372°F), resulting in a dense, low-porosity structure. These factors collectively contribute to the plate's designation as porcelain, characterized by its remarkable hardness, mechanical strength, and translucency when exposed to elevated temperatures. This classification is rooted in both empirical observations and ceramic expertise.

The process of preparing the ceramic body involves mixing water with the raw materials to create a soft and flexible texture, similar to clay. This mixture can be shaped using various techniques like hand-building, wheel-throwing, or casting techniques.

2.2. Technology of Ceramic Production Process

Ceramic production is a meticulous process that begins with shaping clay and culminates in high-temperature firing. This journey comprises essential steps: shaping, drying, glazing, and firing. These techniques create unique and functional ceramic products.

The ceramic production process in Thailand, as in many other regions, follows a sequence of stages that have been refined over time to ensure the creation of high-quality ceramic pieces. The four stages of moulding, drying, glazing, and firing are essential steps that contribute to the overall quality, durability, and aesthetic appeal of the finished product.

Based on Nguyen Van Dung (2009), Ceramic Production Technology, Asian ceramic production following steps are involved:

Moulding: The signs of the moulding process on the plate include its circular shape and the details created using hand-moulded casting technique. This moulding is a high - quality ceramic dish with the desired shape.

The first stage of the ceramic production process is moulding. In this step, skilled artisans shape the clay into the desired form, in this case, a circular plate. There are various techniques for molding, including hand-moulding, wheel-turning, or using molds. Hand-molding involves manually shaping the clay using hands and tools, allowing for more artistic freedom and individuality in the final product. In the molding stage, skilled artisans apply meticulous techniques to ensure the creation of a high-quality ceramic plate. They employ a combination of hand-molded casting and wheel-turning techniques to shape the clay into the desired form.

Hand-molded casting involves manually shaping the clay using hands and tools. This technique allows artisans to have more artistic freedom and control over the final shape and details of the ceramic plate. They carefully manipulate the clay, applying pressure and precision to create the desired form and ensure uniformity.

Wheel-turning techniques: the presence of smooth curves, concentric circular patterns, and precise rotational lines on the plate indicates the characteristic features of wheel-turning techniques. These characteristics demonstrate the skill and expertise of artisans who employed distinct rotations on the pottery wheel during the ceramic production process.

Wheel-turning, also known as wheel-throwing or pottery wheel techniques, is another essential method employed during the moulding stage. Skilled artisans use a potter's wheel, which is a rotating device, to shape the clay. By carefully centering the clay on the spinning wheel, they can apply controlled pressure and movements to pull and shape the clay into the desired form. This technique helps achieve consistent shapes, symmetry, and smooth curves in the ceramic plate (Nguyen Van Dung, 2009).

Wheel-turning techniques play a significant role in ceramic production, specifically during moulding. Wheel-turning, also known as wheel-throwing or pottery wheel techniques, involves using a potter wheel to shape the clay into the desired form. Wheel-turning techniques work including:

Preparation: The potter's wheel, a rotating device, is prepared for use. The wheel is typically made of a flat circular surface that can spin freely. It is mounted on an axle and connected to a motor that enables controlled rotation.

Centering: The potter begins by preparing a ball of clay, which is placed at the center of the spinning wheel. The potter‘s hands and fingers carefully position the clay in the middle of the wheel.

Opening: As the wheel spins, the potter applies gentle pressure with their hands to create an indentation in the center of the clay. This initial depression known as "opening" is the starting point for shaping the piece.

Pulling and Shaping: With the center established, the potter's hands and fingers work to shape the clay. By applying varying pressure and controlled movements, the potter pulls the clay upward and outward to create the desired form. The potter's hands act as tools, guiding and manipulating the clay into the desired shape and thickness.

Trimming: After the initial shaping, the potter may use tools like a trimming or knife to refine the contours and remove excess clay. Trim helps achieve a more precise shape and smooth finish.

Finishing Touches: The potter can add details or decorations using various techniques once the desired shape is achieved. This may include carving, stamping, or adding texture to the surface of the clay.

The wheel-turning technique offers several advantages in ceramic production. It allows for consistent shaping, symmetry, and control over the form of the piece. The rotation of the wheel enables the potter to shape the clay evenly and create smooth, balanced curves. It also provides the opportunity for intricate details and precise measurements, as the potter can adjust the pressure and movement of their hands accordingly (Nguyen Van Dung, 2009).

Drying: The ceramic piece is left to dry after the moulding stage. During drying, excess moisture in the clay gradually evaporates, and the clay hardens. Preparing the report for further processing and preventing deformation during firing is essential. Drying can be time-consuming, as it is necessary to control the drying rate to avoid cracks or warping. It is common for ceramic pieces to be dried slowly and evenly to ensure the best results.

The drying stage in ceramic production is crucial in preparing the moulded clay for further processing and firing. Some additional details about the drying technique used in ceramic include:

Gradual Moisture Evaporation: The ceramic piece is set aside in a controlled environment to allow gradual moisture evaporation. This process helps to remove excess water content in the clay uniformly. Drying slowly and evenly minimises the risk of cracking, warping, or other deformations.

Air Drying: Air drying is the most common method used in the drying stage of pottery. The ceramic pieces are placed on flat surfaces or racks in a well-ventilated area. This allows air to circulate the clay, facilitating the gradual evaporation of moisture. The drying time can vary depending on factors such as the size and thickness of the ceramic piece, as well as the ambient humidity and temperature.

Controlled Drying: Maintaining the drying rate to prevent uneven shrinkage, cracking, or warping issues is essential. Rapid drying can cause the outer layers of the clay to dry faster than the inner layers, leading to stress and potential damage. To achieve controlled drying, artisans may cover the drying ceramic pieces with plastic or fabric to slow down moisture evaporation. This helps to maintain a more balanced drying process.

Turning and Flipping: The signs of turning and flipping can be observed on the plate through consistent thickness, smooth surfaces, and symmetrical features. These characteristics indicate that the vessel was carefully turned and reversed during the ceramic production process to ensure uniformity and balance in its form.

Artisans often turn and flip the ceramic pieces periodically during the drying stage. This ensures that all sides of the clay receive equal exposure to air, promoting even drying and preventing uneven moisture distribution. Turning and flipping also help to prevent the piece from sticking to the drying surface.

Drying Time: The length of the drying process can vary depending on several factors, including the size, thickness, and complexity of the ceramic piece, as well as the ambient conditions. Small and thin pieces may dry relatively quickly, while larger or thicker pieces may require more time. It is essenstial to exercise patience and allow the clay to dry completely before proceeding to the next stage.[9]

By employing careful and controlled drying techniques, artisans aim to achieve optimal results in the ceramic production process. The gradual evaporation of moisture ensures that the clay hardens uniformly and is ready for glazing and firing. It is a critical step

[9] *Nguyễn Văn Dũng. 2009. Công nghệ sản xuất gốm sứ, NXB Khoa học kỹ thuật, . Nguyen Van Dung.2009. Ceramic Production Technology, Science and Technology Publishing House, Vietnamese version*.

in preventing deformations and ensuring the overall quality and durability of the finished ceramic piece.

Glazing: Glaze is a liquid mixture of minerals and other materials that provide colour, texture, and a protective layer to the ceramic surface. Glazes can come in various forms, including transparent, opaque, glossy, matte, or textured, adding aesthetic value to the finished piece. Artisans carefully apply the glaze to the surface of the ceramic using brushes, sprayers, or dipping techniques. This stage requires precision and attention to detail to ensure an even and consistent glaze application.

Firing: This is a critical stage in the ceramic production process, involving the application of intense heat to transform clay into a solid, durable, and functional ceramic object. This process occurs in a specialised kiln designed to withstand high temperatures and provide controlled heating and cooling environments.

The firing process is essential for achieving the ceramic's desired strength, durability, and aesthetic qualities. It transforms raw clay into a functional and visually appealing object. Skilled potters and ceramic artists deeply understand of firing techniques, allowing them to achieve specific effects, such as different glaze textures, colours, and finishes.

The firing of ceramics typically involves two main stages: bisque firing and glaze firing. Each stage serves specific purposes and contributes to the overall quality and characteristics of the final ceramic piece.

Bisque Firing: The first firing stage is known as bisque firing or biscuit firing. Bisque firing removes water and organic materials from the clay, strengthens the ceramic structure, and prepares it for glaze application. The firing temperature for bisque firing ranges from 700 to 1100°C (1292 to 2012°F).

During bisque firing, the kiln temperature gradually rises, driving off any remaining moisture in the clay. As the temperature increases, organic materials, such as plant fibres or binders, burn away, leaving behind a porous but solid ceramic object called a bisque ware. Bisque firing makes the ceramic more rigid and less prone to warping or cracking during subsequent glaze firing [10].

[10] Don Hein,2008, *Ceramic Kiln Lineages in Mainland Southeast Asia,* 3-9 pages

Glaze Firing: After bisque firing, the ceramic piece undergoes glaze firing, where the glaze is melted and bonded to the ceramic surface. Glaze firing temperatures are typically higher, ranging from 1200 to 1400°C (2192 to 2552°F). The specific temperature depends on the type of clay, glaze composition, and desired effects[11].

The kiln is heated to the appropriate temperature during glaze firing, causing the glaze to melt and form a liquid layer. The molten glaze flows and interacts with the clay body, creating chemical reactions that bond the ice to the ceramic surface. The glaze solidifies into a complex, vitreous coating as the kiln gradually cools.

The firing process is carefully monitored to control temperature, heating, and cooling rates. Sudden temperature changes or rapid cooling can lead to thermal shock, causing cracks or damage to the ceramic. Therefore, a regulated cooling method, commonly called tempering or kiln cooling, is employed to gradually lower the kiln temperature and ensure the uniform cooling of the ceramic piece.

The analysis of the ceramic body allows for a better understanding of its composition and structure. This knowledge is valuable for the artefact's conservation and preservation, ensuring its future sustainable maintenance. By studying the ceramic body, experts can develop appropriate strategies and techniques to prevent deterioration, minimise the impact of environmental factors, and ensure the plate's longevity.

Regarding the plate, an application of the literature reveals that the plate is crafted utilizing the following technical traits.

The shaping process involves utilising various techniques to achieve the desired form of the plate. A combination of hand-building and wheel-turning techniques is employed in this specific object. Hand-building leaves noticeable marks from pinching, coiling, or layering, resulting in intricate patterns. In contrast, wheel-turning creates uniform, symmetrical shapes. The central axis is apparent as the form extends outward, and surfaces exhibit evenness while thickness and curves remain consistent.

After the shaping process, the ceramic body is typically dried to remove moisture and prepare it for firing. The ceramic body is exposed to high temperatures in a kiln during

[11] Jirattikorn, A., & Kaewsrichan, J. (2019). Microstructure and properties of kaolin-based ceramics from firing at 800 to 1000°C. Journal of Asian Ceramic Societies, 7(2), 206-215.

firing. The heat causes chemical reactions within the ceramic body, resulting in the material's hardening and forming a solid, durable ceramic structure.

The surface finishing of the fired ceramic body provides the base on which additional surface elements, such as glazing and decorations, are applied to enhance the aesthetics and functionality of the ceramic object. Its design features a low rim and a shallow interior on the front side, providing a subtle and elegant aesthetic. The plate is adorned with vibrant abstract art patterns.

One thing to note about the decorative surface is the presence of small holes. These holes are likely the result of bubbles formed during the firing process.

A silk-mat black glaze is imparted on the back of the plate with a smooth finish. The base of the dish features a low foot without glaze, measuring 6mm in height and 5mm in width. The intentional absence of glaze on the ground gives it a slightly rougher texture, providing better friction and preventing the plate from quickly slipping on surfaces. Moreover, a notable technical issue in this production is the creation of unglazed foot rims for the plate. Instead of using the traditional method of dipping ceramics in glaze before firing, an alternative technique involving the use of fabric has been proposed.

In this process, ceramic products are designed to have unglazed foot rims from the beginning, and then a layer of fabric is applied before glazing and firing. This technique offers several advantages, including the ability to express artistic and creative aspects on the surface of the product.

In addition, regarding this shaping technique, it is mentioned that the marks "86" or "98" are inscribed as lines or scratches. However, these do not appear to be scratches from usage; they seem to be a part of the manufacturing process of the plate. This deliberate technique ensures stability and adds a functional element to the design, showcasing careful craftsmanship in the production of this ceramic piece.

These techniques exemplify the diversity within ceramic plate production and highlight how artistic expression can be incorporated into ceramic products.

2.3. Glaze and decorations

Glaze, in the context of ceramics, refers to a glassy coating applied to ceramic or earthenware objects. It is a durable and stable material that the ceramic surface's functionality and aesthetic appeal [12].

The primary purpose of glazes is to create a sealed barrier on the ceramic surface, preventing the absorption of liquids and making the object impermeable. This property is especially significant for functional ceramics, like plates, bowls, and cups, as it allows them to hold liquids without seepage or leakage.

In addition to its functional role, glaze also offers a wide range of decorative possibilities. It provides a smooth and glossy finish to the ceramic surface, enhancing its visual appeal. Glazes can be formulated in various colours, allowing creative and artistic expression. Different textures and finishes, such as matte or glossy, can be achieved using specific glaze compositions and firing techniques.

In ceramics, glaze is a mix of minerals and water. When applied to ceramics and fired at high temperatures, it undergoes chemical changes. Key chemistry involves mineral selection. When these minerals heat up, they melt and fuse into a glassy layer. This layer makes ceramics impermeable to liquids and allows for creative expression. Glaze is a chemically crafted art medium, showcasing the union of chemistry and artistry in ceramics.[13]

Applying glaze to ceramic objects involves carefully preparing the mixture, typically consisting of finely ground minerals or oxides mixed with water. The prepared glaze is then applied to the ceramic surface by brushing, dipping, or spraying. The object is fired in a kiln at high temperatures, causing the frost to melt and fuse with the ceramic body. This process transforms the ice into a glassy coating that bonds securely with the underlying ceramic material (R. Casasola, Jesús Ma. And Rincón Maximina Romero, 2011).

[12] R. Casasola, Jesús Ma. And Rincón Maximina Romero, 2011, *Glass–ceramic glazes for ceramic tiles: a review*, Springer Science+Business Media, LLC 2011

[13] Steve Mattison, 2010, *Glazes: Materials, Recipes and Techniques,* Publisher: A&C Black.

The Glazing results is a ceramic object with a smooth, durable, and visually appealing surface. The glaze not only enhances the functionality of the thing by making it impermeable but also provides an opportunity for artistic expression and creativity.[14]

Decoration (on ceramics) regards a wide range of artistic techniques, such as glazing, carving, inlay, painting, relief, decals, lustreware, embossing, majolica, underglaze painting, stenciling, transfers, and thematic inspirations. These techniques enhance the visual appeal and meaning of ceramic objects, turning them into functional works of art. It involves the use of various techniques, materials, and motifs to create intricate patterns, designs, and images[15].

As per the author Nguyen Van Dung, decoration on ceramics is commonly seen as follows:

Glazing: The application of glaze to create a smooth finish. Glazes can come in various colors and textures, enhancing the aesthetic appeal of ceramics.

Carving: The process of etching or carving designs, patterns, or textures into the ceramic surface. This can add depth and detailing.

Inlay: The insertion of contrasting clay or other materials into the ceramic surface to create decorative patterns or imagery.

Painting: The use of pigments and brushes to hand-paint designs or scenes onto the ceramic object.

Relief Work: The creation of three-dimensional designs by sculpting the ceramic surface, often using techniques like raised glazing.

Decals: The application of ceramic decals or transfers with pre-designed patterns or images onto the surface.

Lustreware: The application of metallic glazes to create a shiny, reflective surface.

Embossing: Creating raised patterns or designs by pressing the ceramic surface from behind.

[14] R. Casasola, Jesús Ma. And Rincón Maximina Romero, 2011, *Glass–ceramic glazes for ceramic tiles: a review*, Springer Science+Business Media, LLC 2011

[15] *Nguyễn Văn Dũng. 2009. Công nghệ sản xuất gốm sứ, NXB Khoa học kỹ thuật, . Nguyen Van Dung.2009. Ceramic Production Technology, Science and Technology Publishing House, Vietnamese version*

Majolica: A type of decoration where colorful, opaque glazes are applied to create vibrant, detailed designs.

Underglaze Painting: Painting directly on the ceramic surface before the application of the final glaze.

Stenciling: Using stencils to apply precise patterns or designs.

Thematic Inspirations: Drawing inspiration from various themes, cultures, or historical periods to create designs that convey specific meanings or stories.

In the case of the plate, the decoration is a crucial element that elevates its aesthetic value. Decorative techniques, including raised glazing and relief glazing, have been utilised to add depth and dimension to the patterns on the plate. These techniques involve the precise application of multiple layers of glaze in different colours and patterns, resulting in a three-dimensional effect with raised ridges and intricate detailing. The use of relief glazing, in particular, creates a captivating play of light and shadow, accentuating the contours and intricacies of the design.

The traditional glazing techniques employed during production contribute to the plate's aesthetic appeal. Applying glazes, such as the silk-mat black glaze on the back and the colourful abstract art patterns on the front, adds depth, texture, and visual interest to the plate. These glazes enhance the plate's appearance and provide a protective layer that safeguards the ceramic surface. The artist has employed a range of decorative techniques to bring the plate to life. The design features a mesmerizing array of vibrant colors, seamlessly transitioning from one to another, forming symbolic and eye-catching images that captivate viewers.

This ceramic plate is a remarkable example of the artist's skill and craftsmanship, showcasing a harmonious blend of shiny, matte, and glossy finishes that create a visually stunning effect. The top surface of the plate features a smooth and shiny glaze, meticulously applied using techniques such as dripping, brush application with fingers, and dipping glaze. These methods result in a seamless integration of vibrant colours, producing an exquisite palette that captivates the viewer.

The design on the plate is a testament to the artist's expertise and creativity. Traditional techniques such as raised and relief glazing have been employed to enhance the patterns, adding depth and dimension to the artwork. Multiple layers of glaze in different colours and practices have been carefully applied, resulting in a mesmerising three-dimensional effect with raised ridges and intricate detailing. Each design element has been executed precisely and skillfully, highlighting the artist's attention to detail.

The plate’s texture varies across its surface, creating an engaging tactile experience. Some areas exhibit a rough, sandy texture, resembling the feel of natural sand, while others are smooth and glossy. This contrast in texture adds depth and visual interest to the piece, enhancing its overall aesthetic appeal.

The underside of the plate is coated with a silk-matte black glaze, which not only adds an elegant touch but also serves a practical purpose. It protects against scratches and ensures the longevity of the ceramic piece. The glaze material has been carefully selected to achieve the desired appearance and durability.

The production process of this ceramic plate involves meticulous attention to detail. The artist carefully chooses the glaze materials, considering colour, texture, and compatibility factors. The glaze application requires precision and expertise to achieve the desired finishes and effects. The plate is fired at high temperatures, allowing the glaze to melt and fuse with the ceramic, resulting in a durable and long-lasting of art.

The careful selection of materials, including clay and glazes, along with the meticulous execution of the production techniques, ensures the high quality of the final product. In the production of ceramics in Asia, particularly in Thailand, a wide range of glaze materials are utilised. These materials are crucial in creating the final ceramic products' desired aesthetic and functional properties. There are several commonly used types of glaze materials in the region that can be discussed as follows:

Traditional porcelain glaze: Traditional glazes are often made from natural materials such as clay, feldspar, and silica minerals. These materials are finely ground, mixed with water to create a glaze mixture, and then applied to the ceramic surface before being fired in a kiln to make the final product.

Ceramic colour glaze: Ceramic colour glazes are used to create different colours on ceramics. These glazes can be made from various materials, including metal compounds such as iron copper, cobalt, chromium, and other metal compounds.

Crackle glaze: Crackle glazes are unique glazes that create a crackle effect on the ceramic surface. Lead oxide and borax are often used to generate crackle glazes. The difference in the coefficient of expansion between the glaze and the ceramic body during firing creates a unique crackle effect.

Raised glaze: Raised glazes create raised patterns on the ceramic surface - unique glazes with the ability to hold their shape after application are used to achieve this Raised glazes can be made from traditional porcelain ceramic- colour materials.

Relief glaze, similar to raised glaze, shares the purpose of creating details and effects on the surface of ceramics. It achieves this by applying a thin layer of ice to specific areas to create subtle relief details. When the ceramic is fired, the ice melts and raises the applied areas, resulting in variations in depth on the surface. This technique often adds patterns, motifs, images, or other decorative elements to ceramics, creating visual interest and enhancing the overall appearance. Both raised and relief glaze serve the same purpose of making detailed effects on the surface of ceramics, but relief glaze focuses explicity on achieving subtle relief details.[16]

Different materials can be utilised to achieve relief glaze depending on specific requirements and desired effects. Here are commonly employed materials (Nguyen Van Dung, 2009):

Glaze: Relief glaze typically involves applying a thin layer of ice onto the ceramic surface. Glazes comprise of mineral mixtures like silica, feldspar, and metal oxides. During firing, these components melt and fuse to form a glossy coating. The choice of glaze affects the final appearance of the relief, including colour, texture, and transparency.

Underglaze: Underglazes are coloured substances applied to the ceramic surface before glazing. They can be pigments or dyes mixed with a medium like water or a clear glaze base. Underglazes enable detailed painting or drawing on the ceramic, which can be enhanced with relief glaze to create a three-dimensional effect.

Slip: Slip is a creamy mixture of clay and water. It can be applied to the ceramic surface using brushes, spatulas, or other tools to create relief. Once the slip dries, relief glaze can be applied on top of it. The slip shrinks slightly during firing, causing the ice to separate and create raised areas.

[16] Trinitat Pradell & Judit Moler, 2020.

Wax resist: Wax resist is commonly made from beeswax or synthetic wax compounds. It is used to create areas where glaze or slip should not adhere. Applying wax to the ceramic surface and adding glaze or slip repels the material, raising relief areas when fired. (Nguyen Van Dung, 2009).

For glaze materials, in the ceramics industry of Southeast Asia, including countries like Thailand, Vietnam, Indonesia, and Malaysia, a combination of natural minerals and oxides is commonly used as glaze materials. These materials are meticulously chosen and processed to develop glazes that exhibit desirable properties and aesthetics, such as:

Feldspar: Feldspar is a critical ingredient in many glazes and is used as a fluxing agent. It helps lower the glaze's melting point, allowing it to fuse and form a glassy surface. Feldspar also contributes to the stability and durability of the ice.[17]

Silica: Silica, usually in quartz, is a primary component in glazes. It acts as a glass-forming agent and helps to create a smooth and glossy surface on the ceramic. Silica also enhances the hardness and resistance to thermal shock of the glaze.

Kaolin: Kaolin, a type of clay, is commonly used as a source of alumina in glazes. It contributes to the viscosity and suspension properties of the ice, ensuring even application and preventing the settling of glaze materials during the firing process.[18]

Limestone: Limestone is sometimes added to glazes as a fluxing agent. It helps to reduce the melting temperature of the ice and promotes the formation of a glassy surface.

Metal oxides: Various metal oxides create specific colours and effects in glazes. For example, iron oxide can produce earthy tones; cobalt oxide can create blue hues, and copper oxide can result in green shades. These oxides are added in small quantities to achieve the desired colouration.

[17] Trinitat Pradell & Judit Moler. 2020. *Ceramic technology How to characterise ceramic glaze*

[18] Kaolinite is a clay mineral formed from aluminum silicate minerals during chemical weathering. It has a layered structure with silica and alumina sheets linked together. At high temperatures, it transforms into metakaolinite, spinel, platelet mullite, cristobalite, and needle-shaped mullite (Trinitat Pradell & Judit Moler. 2020. *Ceramic technology How to characterise ceramic glaze).*

Wood ash: In some traditional ceramics, wood ash is a glaze material. When wood is burned, it produces ash containing minerals like potassium and calcium. These minerals act as fluxes in the glaze and can result in distinctive and unpredictable effects on the ceramic surface. Wood ashes consist of calcium oxide (CaO), potassium oxide (K_2O), aluminum oxide (Al_2O_3), magnesium oxide (MgO), sodium oxide (Na_2O), and phosphorus pentoxide (P_2O_5). Phosphorus in a glaze indicates the use of wood ashes. (Trinitat Pradell & Judit Moler, 2020).

In the glazing process of ceramic production in Southeast Asia, including Thailand, artisans use various techniques to achieve desired glaze effects and aesthetics. Some of these techniques include:

Hand Glazing: Using brushes, artisans skillfully apply the glaze onto the ceramic surface. This meticulous method allows precise control over the glaze application, ensuring an even smooth coating.

Figure 5: Glaze and decorations of the plate.

Figure 6 : Silk-matte black glaze.

Dipping: The ceramic piece is submerged into a glaze solution, ensuring complete coverage. This technique is commonly used for small or regular-shaped ceramics to achieve consistent glaze layers.

Spraying: Using sprayers or airbrushes, artisans create a fine mist of glaze particles that uniformly coats the ceramic surface. This technique is ideal for larger or irregularly shaped ceramics and allows for thin and even glaze layers.

Pouring: Glaze is poured directly onto the ceramic piece, allowing it to flow and settle evenly. This technique can create unique patterns and effects, mainly when using multiple glaze colours.

These techniques are executed precisely considering viscosity, glaze thickness, and desired visual effects. Artisans' expertise and experience are crucial role in achieving the desired glaze appearance.

The glazing techniques used in Southeast Asia, particularly in Thailand, produce ceramics with a wide range of effects, such as glossy, matte, translucent, opaque, or textured surfaces. Combined with the firing process at high temperatures, these techniques result in stunning and functional glazed ceramics that reflect the region‘s rich artistic heritage.

This ceramic plate under investigation exemplifies the artistry of glazed ceramics with its captivating blend of colours and textures. The top surface of the plate displays an arrangement of colours that transition smoothly, forming a visually striking image.

One notable feature of the plate is the background layer coated with a silk-matte black glaze. Combining this black shade with the other colours on the leaf produces a visually pleasing colour effect. The chosen colours encompass shades of blue, purple, red, and brown, complemented by playful cobalt blue speckles.

Additionally, the plate patterns employed demonstrate the practical and intricate use of the relief glaze technique. This complex process creates a captivating three-dimensional effect, with the design featuring intricate patterns, borders, and raised ridges measuring 1-1.5 mm in height. These elements add depth and texture to the overall composition. Unique glazes that retain their shape after application are carefully selected to achieve the desired thickness.

Combined with relief glazing, the raised glaze technique incorporates various materials, including traditional porcelain glaze, ceramic colour glazes, and other materials. The careful selection of colours further enhances the design's sense of harmony and beauty.

The underside unveils a sleek silk-matte black glaze coating, typically consisting of minerals, oxides, and other additives[19]. This adds a touch of elegance and the practical purpose of protecting the ceramic from potential scratches and damage.

[19] Two main substances that could have been used to create the black colour in silk-mat black glaze coating may consits of managanese dioxide (MnO_2) and iron oxide (Fe_2O_3).

3. Condition survey

A condition survey is a comprehensive assessment and evaluation of objects to determine their overall state, identify existing damages, and assess potential risks or vulnerabilities. It systematically examines the ceramics, considering structural integrity, surface condition, material composition, and decorations.

The primary objective of a condition survey is to document the condition of ceramic objects in detail in order to develop a conservation concept. It involves inspecting the ceramics for any signs of damage, such as cracks, chips, fractures, or warping, which can affect their stability and longevity. The survey also aims to identify any indications of deterioration, such as flaking, blistering, discolouration, or loss of detail.

Figure 7: A broken section of the plate.

3.1. C3.1. Ceramic body

A condition survey of the ceramic body involves assessing the physical state of the ceramic object, including its surface, structure, and stability. This work also aims to find damages, deterioration, and potential risks to ensure proper preservation and take conservation decisions.

During the survey, it becomes evident that dust and dirt have accumulated on the surface of the plate. These accumulations can significantly impact the plate's appearance and potentially compromise its long-term preservation. Therefore, it is crucial to discuss the nature of dust and dirt and their effects on the plate within the context of the condition survey.

Technique survey is a critical step in assessing and documenting the condition of ceramic objects comprehensively. This process involves examining various aspects of the object, including its physical attributes and surface characteristics.

Regarding the plate, the physical state of the plate includes a sturdy and smooth ceramic body with decorations featuring multicoloured patterns. The surface is uneven, with raised decorative elements. The bottom surface is coated with a silk-matte black glaze, exhibiting a solid and smooth structure.

Additionally, the bottom surface of the plate presents a noteworthy feature. It is coated with a silk-matte black glaze, contributing to the plate's visual contrast and elegance. This glaze exhibits a solid and smooth structure, further enhancing the plate's overall durability and functionality. Furthermore, the technique survey clearly reveals that the base of the plate is unglazed. It is evident that this is a glazing technique associated with the use of fabric. This technique has been employed to create a wide range of variations in glazing techniques for artistic ceramics.

The plate shows a significant problem due to extensive damage, mainly from a large crack that caused the plate to break into pieces measuring 10 cm long, 3.3 cm wide, and 5 mm thick. This damage, accompanied by multiple fragments, suggests a possible crash during transportation or a significant impact, leading to fragmentation.

The sizeable broken parts debris create a structural gap due to material loss. The presence of this damage significantly affects the aesthetics and structure on both the front and back surfaces of the plate. The gap poses a risk of additional harm contribute to the overall deterioration of the container. Urgent attention and appropriate conservation measures are paramount to stabilising the broken sections and preventing further separation.

Figure 8 :The broken piece and its crumbled fragments.

Moreover, the plate shows small holes that have allowed dirt and deposits, compromising its visual appearance. These deposits can cause discolouration and disrupt the overall presentation of the decorative elements. Cleaning and conservation techniques are essential to resolve these issues and restore the plate's aesthetic qualities.

Examining the bottom of the plate reveals a dark, silk-matte black glaze. While the ice appears intact, the edges exhibit signs of wear, indicating possible contact with abrasive surfaces. The bottom surface shows evidence of dust accumulation, sticky marks from old adhesive residue, scratches, small pits, and holes filled with deposits. The delicate layers of the glazing structure have suffered damage.

In summary, the condition survey of this plate highlights significant issues such as cracks, crack lines, dust and dirt accumulation on both side of the plate; wear on the edges and bottom surface. These problems are primarily caused by environmental factors, especially the hygroscopic nature of dust and dirt particles, which means they readily absorb moisture from the surroundings. Other contributing factors may include exposure to air pollutants, improper storage conditions, and handling over time. These observations emphasize the importance of implementing appropriate conservation measures to stabilise the damaged sections, clean the surface, and restore the missing portions of the glaze structure. The plate can be preserved and displayed in its intended form through conservation and restoration, allowing future generations to appreciate its beauty and historical significance.

3.2. Glaze and decorations

The ceramic surface is covered by a thin protective layer known as glaze, It serves a dual purpose: it acts as a shield against environmental influences and enhances its aesthetic appeal. The decoration involves adding supplementary elements to heighten interest and artistry, such as painting, colouring, printing, or applying materials onto the ceramic surface. This elevates the visual allure and artistic worth of the piece.

In the context of this plate, attention is focused on three vital aspects: the existence of cracks and fragmented portions, scratches contributing to glaze deterioration, deposits and stains on the surface. Cracks and fractures bear the potential to cause significant harm to the plate scratches and compromised glaze impact visual appeal and compromise the entire surface's structural integrity. Deposits and stains additionally detract from the visual magnificence of the decorative components.

After a comprehensive evaluation, a spectrum of conservation approaches is recommended to ensure the preservation and protection of this ceramic plate. This entails stabilising and restoring compromised and fragmented sections. Concerning scratches and glaze attrition, a crucial step involves refreshing the surface to reinstate its original aesthetic essence.

3.2.1. Cracked glaze and broken parts

Cracks and broken parts often happen with ceramic objects, which is expected in the ceramic world. They can look different and be caused by what the ceramic is made of and what happens to it from the outside. (Fig.9).

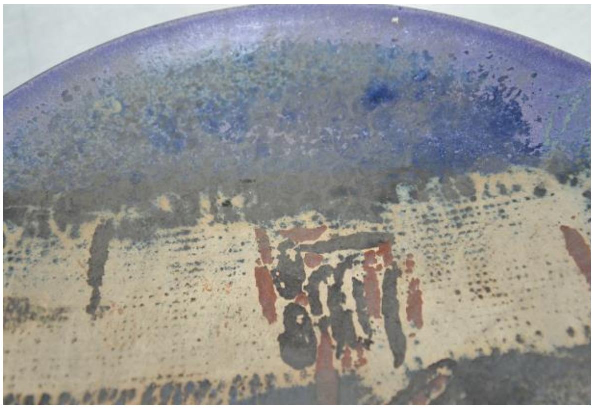


Figure 10: The discolouration and scattered cracks on the plate's surface.

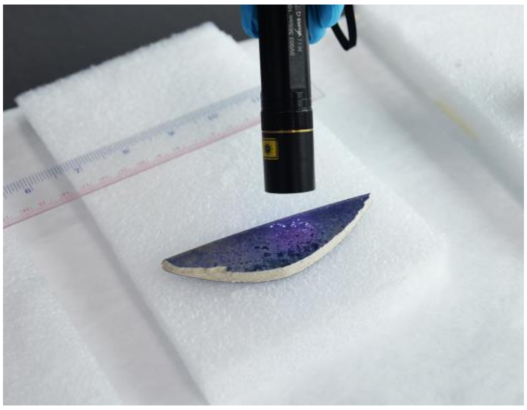


Figure 9 : Saw-tooth crack pattern and glaze distortion on the broken fragment.

Observing the plate, a significant issue becomes apparent: a broken piece detached from the container. A large fragment was found separate from the main body, along with several smaller shards. The notable broken piece measures approximately 10 cm x 3.3 cm x 5 mm (Fig.10). It has detached from the main section of the plate and exhibits signs of impact, including loss of the glazed surface and complete erosion of the glaze layer - the broken fragment is a result of a strong external force that has altered the ceramic structure. External forces, such as physical impact or pressure, can cause cracks and fractures in ceramics. Mishandling, accidental dropping, or improper storage can lead to breakage and fragmented pieces. The broken fragment has created a significant gap and various smaller components. This is considered the most critical aspect for preserving this ceramic plate, and the purpose of the condition survey regarding this broken piece is to explore methods to restore the ceramic fragment to its original state. Upon close examination, the plate surface reveals a network of fine cracks that have developed over time. These fissures vary in size and shape, ranging from thin, hairline fractures to wider crevices. They intersect and branch out, disrupting the patterns and designs on the plate. These features are more noticeable in the sections adorned with multicoloured glazes. In contrast, ceramic plate's black-glazed underside shows fewer visible characteristics of this nature.

The formation of cracks and broken parts can be attributed to the inherent nature of the ceramic material, including its constituents such as clay, minerals, and other additives, which react with each other during the drying and firing process, developing internal stresses within the material. Over time, these cracking phenomena become visible on the surface of the plate.

In addition, temperature and humidity fluctuations can cause ceramics to expand and contract, resulting in thermal stress. Rapid or uneven temperature changes, such as exposure to excessive heat or cold, can exacerbate these stresses and increase the likelihood of crack formation.

The thorough condition survey of cracks and breakages is vital to comprehend the factors and mechanisms responsible for the plate's damage. This understanding is pivotal for effective conservation and restoration. Different methods, can be discussed, such as adhesive bonding, filling missing parts, and reinforcing cracked areas. Careful consideration of the material composition, firing techniques, and specific circumstances surrounding the cracks is essential to ensure the successful restoration of the ceramic object while preserving its authenticity and historical value.

3.2.2. Scratches and losses in the glaze

Scratches and missing glaze on the plate show signs of abrasion and damage, where the ceramic surface protective layer is worn or compromised. Scratches can occur due to friction or contact with abrasive materials. At the same time, losses in the glaze can

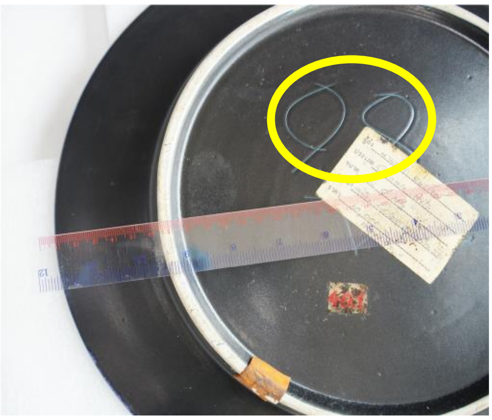


Figure 11 : Carved markings on the back of the plate.

Figure 12 : Missing glaze and some raw materials.

result from various factors such as wear and tear, chemical reactions, or external impacts. These scratches and losses in the ice can contribute to the ceramic object's overall deterioration and aesthetic damage.

The plate has scratches and glaze losses, affecting its condition. Some scratches may be intentional, potentially marking number of 86 (Fig.11). The unglazed foot is a deliberate technique for stability on a kiln shelf. Scratches on the surface trap dirt and weaken the glaze, needing restoration.

Efforts to restore the plate, including addressing glaze losses, scratches, and imperfections, are vital for its preservation. Discussing solutions such as recreating missing glaze, cleaning surface contaminants, and stabilizing fragile areas is essential.

3.2.3. Deposits and stains

Deposits and stains on ceramics can have various origins and significant affect their appearance and condition. Understanding the nature of these deposits and stains is crucial in developing effective cleaning and conservation strategies for ceramic objects.

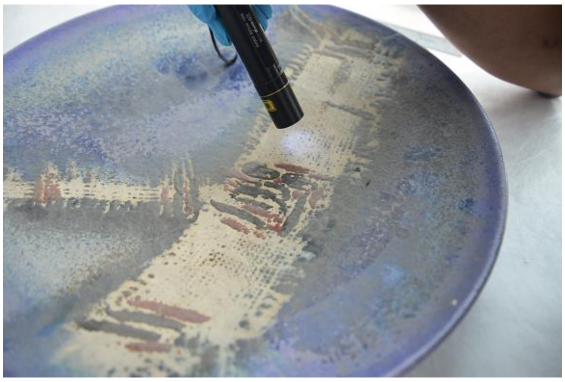


Figure 13: Dirt and dust adhering to the plate surface.

Various factors, including environmental conditions, usage, and improper storage, can cause deposits on ceramics. These deposits are often the result of water or mineral-rich substances coming into contact with the ceramic and leaving behind residues as they evaporate. Common deposits include mineral salts, which create stains and a layer of residue water or the atmosphere. Foggy colours from dust and tiny particles in the air, making a thin film on the surface. If ceramics are used for food storage, food residues can accumulate and create stains. Additionally, oxidisation stains may appear because of air or the surrounding environment. Lastly, usage marks, dirt buildup, fingerprints, and light impacts can all contribute to various deposits on the surface [20].

Organic deposits on the surface of ceramics can occur due to various particles, such as human hair and skin, remains and excretions of dead animals, pollen, and other forms of organic matter. These substances can settle directly onto the ceramic surface or form dust in the surrounding environment. When combined with moisture or humidity, they create an ideal environment for the growth of microorganisms such as algae and mould. This can result in colour changes and the formation of deposits on the ceramic surface. Stains on ceramics can be caused by substances that have penetrated the surface of the ceramic and become embedded in its pores. Familiar sources of colours include food and beverage spills, oils, dyes, and inks. These stains can be particularly challenging to remove, as they can be deeply ingrained in the ceramic and resistant to conventional cleaning methods such as dish soap, water, scrubbing or sponges.

During the condition survey, it was evident that the ceramic plate exhibited noticeable deposits and stains. These deposits and stains had accumulated over time due to exposure to environmental factors such as dust, dirt, and humidity. The hygroscopic nature of the particles in the dust and dirt allowed them to attract and retain moisture from the surrounding air. As humidity levels fluctuated, the absorbed moisture facilitated chemical reactions between the particles and trace elements, contributing to the formation of stubborn stains and deposits on the surface. The accumulation of sediments and stains can obscure the plate's original colours and intricate details, diminishing its visual appeal.

Deposits and stains can hide the fine details and beauty of a plate. These marks can make a plate look older and less appealing. Keeping leaves free from deposits and stains is essential to preserve their value.

[20] Norman H. Tennent, 1999, *the Conservation of Glass and Ceramics,* Publisher James & James, London

These marks create a damp environment where mould and mildew can grow. Organic materials in sports also feed microorganisms, causing discolouration and damage.

Figure 15:The condition of the back.

Figure 14 :Examining residues with UV light.

In the case of the plate, dust and dirt particles can settle on the surface of the container over time, gradually forming a layer that obscures its original colours and details. This layer of debris can make the plate appear dull, diminish its visual appeal, and cover any intricate designs or patterns. In addition, dust and dirt can provide a breeding ground for microorganisms, further depleting the plate's condition addressed.

Dust and dirt can also lead to abrasion or scratching when the plate is handled or cleaned. These particles act as abrasive agents that can create fine scratches or wear down the surface of the glaze and decoration. Over time, this can cause irreversible damage and impact the overall aesthetic value of the plate.

In conclusion, deposits and stains on ceramic plates can lead to deterioration, loss of details, harmful microorganism growth, and understanding of their cultural significance.Therefore, it is crucial to address this issue through proper cleaning and preservation methods.

4. Aim and concept of the conservation

The conservation aims to preserve and protect the ceramic object, ensuring its longevity, and cultural significance. Protection involves understanding the object, addressing any issues that it may have, and maintaining its condition while respecting its historical and artistic significance.

The conservation of the plate aims is to prepare it for exhibition and storage purposes. Conservation efforts focus on stabilising its structure and addressing aesthetic concerns to enhance its visual appeal while preserving its authenticity. Additionally, measures are taken to create a controlled environment during storage to protect the plate from deterioration.

Conservation issues address cracks, breakages, losses in glaze, and other forms of damage that can compromise the structural integrity and aesthetic value of ceramics. Considering the plate specific properties and vulnerabilities, conservation professionals use appropriate methods and materials to stabilise and repair the object.

Conservation also involves thorough documentation and research to understand the ceramic object’s historical and cultural context. This includes studying its production techniques, material composition, decorative elements, and historical significance. Through learning about the object's history, conservation experts can make intelligent choices about fixing and restoring it, while keeping it genuine and aunthentic to its origins.

Another important aspect of ceramic conservation is preventive care and risk management. This involves creating suitable storage and display conditions, implementing proper handling and transportation protocols, and developing maintenance strategies to minimise the risks of damage or deterioration. Preventive measures aim to mitigate environmental factors such as temperature, humidity, light exposure, and physical stresses that can negatively impact ceramic objects.

Furthermore, conservation emphasises the ethical responsibility to respect and preserve the cultural heritage of ceramics and its history. This involves reversibly and minimally conducting conservation interventions, ensuring the original materials and techniques remain as intact as possible. Conservation professionals work closely with curators, archaeologists, historians, and other stakeholders to balance the preservation needs of the objects with the interpretation and display requirements of cultural institutions.

4.1. Dry surface cleaning

Dry surface cleaning is crucial for preserving the ceramic plate. It involves gently removing dirt and debris from the surface of ceramic objects without using of any liquids or solvents. Dry cleaning slowly removes dust particles, which can scratch the surface. This ceramic plates' historical and aesthetic value by reducing the risk of damage caused by the accumulation of dirt over time. It involves carefully and gently using of soft-bristled brushes, cotton swabs, and sponges to remove loose particles and clean hard-to-reach areas on the plate surface. Regularly practising dry surface cleaning ensures, the integrity of the glaze and the underlying ceramic material can be better maintained, ensuring the long-term preservation of the ceramic plate.

The first step is choosing the appropriate tools for dry cleaning. It is recommended to start with a vacuum cleaner and soft brushes. This ensures that the surface of the ceramic plate is not scratched or damaged during cleaning. The soft brushes help to gently lift and remove loose particles without causing any harm.

Once the vacuum cleaner with soft brushes is ready, it should be carefully used on the ceramic plate. The soft brushes should be moved gently and smoothly across the surface, targeting areas where dirt and debris have accumulated.

During the dry cleaning paying attention to hard-to-reach areas and intricate details on the plate is essential. Cotton swabs or soft brushes can be used to delicately clean these areas, ensuring that no debris is left behind. Being meticulous yet gentle is key, letting the tools perform their tasks without unnecessary force.

Following the appropriate sequence of using a vacuum cleaner with soft brushes, and sponges significantly reduces the risk of scratching or damaging the ceramic plate during the dry cleaning. This method ensures the plate's surface remains clean and well-preserved, maintaining its historical and aesthetic value over time.

4.2. Wet cleaning

Wet cleaning is an essential technique used in the conservation of ceramic plates. Its aims to effectively remove stubborn dirt, and contaminants that cannot be adequately eliminated through dry cleaning. This is achieved by applying a carefully selected cleaning solution that is strong enough to remove the pollutants and gentle enough to protect the plate's surface and glazed areas.

These solutions, such as deionised/distilled water, ethanol, acetone, or other options, undergo testing to ensure they are compatible and effective without causing any damage. To ensure the effectiveness of wet cleaning, conducting a small-scale test on a discreet area of the plate is crucial.

Once the suitable cleaning solution is identified, it is applied to the plate using a sponge or cotton swab. By following this approach, wet cleaning can successfully address specific contaminants and stains.

In the case of this particular plate, a wet cleaning method will be employed to remove substances adhered to its surface and residues accumulated in its crevices over time. The wet cleaning process involves a range of solutions, such as sponges, damp cloths, solvents, water, and surfactant cleaning solutions. The primary aim is to remove stubborn substances while preserving the plate's integrity.

4.3. Gluing broken pieces

Gluing broken pieces is an essential step in conserving a plate, as it helps to restore its structural integrity and prevent further damage. The gluing of broken pieces aims to create a solid and durable bond that will hold them together and ensure they are aligned correctly.

The concept of gluing broken pieces involves using a suitable adhesive that is compatible with the material of the plate and can provide a solid and long-lasting bond. The choice of adhesive will depend on factors such as the plate's material, the damage's extent, and the container's intended use.

In general, the adhesive used for gluing broken pieces should be strong, flexible, and reversible, meaning that it can be removed, if necessary without causing damage to the plate.

Various types of adhesives are considered for bonding, including epoxy resins, acrylic adhesives and natural, animal-based glues. While these alternatives, such as acrylic adhesives and animal-based sealants, offer potential solutions, they are less widely available or commonly used in Thailand, Vietnam, and other Southeast Asia countries.

In the case of this plate, epoxy glue emerges as the optimal choice for conserving its fragmented pieces. Epoxy's versatility, strong adhesive properties, and compatibility with ceramic materials make it an ideal candidate for restoration. Its availability in the region further contribute to its suitability for the conservation process.

Epoxy includes a range of core elements and the resulting cured forms originating from epoxy resins. These resins, often referred to as polyepoxides, belong to a category of reactive prepolymers and polymers that feature epoxide groups. The term "epoxy" is a collective reference to the epoxide functional group, including Epoxy resin and Hardener [21].

Epoxy resin is typically a clear or pale-yellow liquid. Hardener is a chemical compound that, when mixed with the epoxy resin, initiates a chemical reaction. This reaction leads to the curing or hardening of the epoxy. The hardener is usually a colorless liquid.

Its advantages include strong bonding, heat and chemical resistance, ideal for ceramic restoration. However, challenges include color matching, irreversibility, safety concerns, and potential visibility of repairs. Balancing these aspects ensures successful ceramic restoration while preserving its authenticity and historical value. (May, Clayton, 2018).

Epoxy resins, composed of two mixed components before application, allow for precise control during bonding. Its gap-filling capabilities are particularly beneficial for securely joining uneven surfaces. Moreover, epoxy's stability over time, resistance to environmental factors, and ability to uphold bond strength align with the long-term preservation needs of valuable ceramic artefacts.

Given both efficacy and practicality, epoxy glue is the preferred and optimal solution for conserving this plate. Its widespread usage and proven track record in the region make it a reliable choice to ensure the artefact's lasting preservation and display.

To determine the most appropriate epoxy for the restoration, a series of tests will be conducted with three brands: Alteco from Thailand, UHU from Germany, and X'traseal

[21] May, Clayton (2018). *Epoxy Resins: Chemistry and Technology* (2nd ed.). CRC Press. p. 65

from Malaysia. These brands have been chosen because they come from different manufacturing facilities in both the Asian and European regions.[22]

The testing process involves applying each adhesive to sample ceramic pieces, after curing, and assessing the quality and effectiveness of the bonding. This preliminary testing is crucial in determining which glue is the most compatible with the ceramic plate, ensuring a successful and durable conservation outcome. The procedure starts by applying each adhesive to sample ceramic pieces, simulating the conditions and surfaces encountered during the plate restoration. The evaluation encompasses factors such as adhesion strength, transparency, ease of application, and compatibility with the ceramic material.

The results of these preliminary tests will provide valuable insights into which adhesive is most suitable for gluing the broken pieces of the plate. Factors such as the glue's ability to create a strong and durable bond, its compatibility with the ceramic material, and its appearance will be considered in the decision-making process.

To ensure the most efficient gluing of the ceramic plate, a series of discussions and experiments will be carried out. The objective of this endeavor is to evaluate and record the impact of different types of adhesives on various ceramic materials. Once the most appropriate adhesive is determined for each specific type of ceramic, these results will be applied to the actual gluing process of the plate.

4.4. Filling cracks

This process involves applying an appropriate adhesive, filler, or bonding agent to the cracks to restore the integrity and appearance of the ceramic object. The goal is to effectively close the gaps and reinforce the structure of the ceramic, ensuring its stability and preventing further damage.

Cracks in ceramics can vary in size, shape, and depth, and they can occur due to various factors such as mechanical stress, thermal shock, manufacturing defects, or ageing processes. These cracks can impact the structural integrity of the ceramic object and may lead to further damage or deterioration if not appropriately addressed. Repairing

[22] Alteco glue Thailand of alpha Unittrade Co.,LTD. Exclusive dealer of Alteco in Thailand; UHU Enfest from Germany is manufactured by the company UHU GmbH & Co. KG; X'traseal is produced by Mohm Chemical Sdn. Bhd, Malaysia.

ceramic cracks often involves filling, gluing, or sealing techniques to restore the object's strength and aesthetic appearance.

A comprehensive approach is employed to fill in the cracks and reinforce the plate to address this. Depending on the specific restoration requirements, several techniques can be used individually or in combination. One pratical approach involves mixing marble powder with glue to create a paste. This paste is carefully applied to the cracks, ensuring complete coverage and a secure bond. Once applied, the paste undergoes a drying process, solidifying and forming a solid connection with the ceramic surface.

The aim of this plate is not only to mend the visible cracks but also to prevent further deterioration. By applying the paste mixture, it will be ensured that the plate's structural stability is conserved, reducing the risk of future damage. Furthermore, choosing marble powder and glue offers colour, and texture matching benefits, creating a cohesive and harmonious appearance that blends seamlessly with the original plate.

Ultimately, filling cracks in the plate involves a meticulous and adaptable approach. It will be carefully selected and applied with appropriate materials and techniques to address existing and potential gaps, striving to achieve the best possible restoration outcome.

Through expertise, thoughtful analysis, and skilled implementation, the concept aims to revitalize the plate, preserving its historical and aesthetic value for future generations. This approach has been discussed and validated with supervisors, showcasing its potential as a suitable solution for crack filling in the plate conservation process.

4.5. Retouching

The purpose of retouching the ceramic plate, including addressing any missing areas, is to seamlessly blend the repaired sections with the rest of the surface. This restoration process aims to restore the plate's aesthetic value and conceal any signs of repair work. It involves matching the colour and texture of the filled and missing areas with the surrounding ceramic material to achieve a uniform appearance.

Different methods of retouching can be used, depending on the desired outcome. One approach is to mix pigments or colourants that match the ceramic material with a binder, such as glue or resin, and apply the mixture to the filled area using a small brush or airbrush/syringe.

Another technique is called "reintegrated painting," which involves using a small brush to create fine lines or dots that mimic the appearance of natural cracks or imperfections. This helps to make the repair work less noticeable. To protect the retouching, a transparent protective coating can be applied to the painted area.[23]

Coating materials commonly used for "reintegrated painting" include conservation-grade varnish, acrylic mediums, and synthetic resin coatings like epoxy or polyurethane. These materials provide a protective layer over the retouching work, ensuring durability and blending with the surrounding surface. When selecting a coating material, it is essential to consider factors like compatibility and reversibility.[24]

When retouching a glaze on the plate, using acrylic paint is a recommended solution. Acrylic paint can be employed for retouching because it enables convenient colour tone adjustments to match the glaze, resulting in a fresh and uniform plate surface. Additionally, it's more accessible and readily available compared to traditional specialized adhesives.

In addition, another method is called "smudging," in which a soft brush or sponge is used to blend the filled area’s colour with the surrounding surface. This creates a gradual transition of colour and texture that helps to conceal the repair work.[25]

Regarding retouching this plate, there are two methods to consider: "smudging" and "reintegrate". Considering the nature of the retouching work and the goal of the surface, the “smudging” technique is preferred. It creates a seamless transition, softly hiding repair work and achieving a unified appearance. When combined with the original surface, smudging discreetly restores the plate.

Another possible solution for retouching the ceramic plate is to fill the cracks and holes using marble powder without additional retouching. This technique involves mixing

[23] Young, Christina. 1995. "Reintegrated Paint Loss Compensation: A Technique for Ceramic Conservation." Journal of the American Institute for Conservation 34 (1): 1-14.

[24] Young, Christina. 1995. "Reintegrated Paint Loss Compensation: A Technique for Ceramic Conservation." Journal of the American Institute for Conservation 34 (1): 1-14.

[25] McCarthy, J. 2016. "Retouching and Colour Matching of Glazed Ceramics." In Conservation of Glass and Ceramics: Research, Practice and Training, edited by Norman Tennent and David McLeod, 143-147. London: Archetype Publications.

materials and blending colours to match the original colour of the surrounding areas, thereby eliminating the need for further retouching after the filling process. If the consideration of utilising marble in the approach is considered, this would also be a good solution for conserving the ceramic plate.

5. Measures carried out

5.1. Dry surface cleaning

The cleaning process for the ceramic plate began with dry cleaning as the initial step. This method involved the use of a vacuum cleaner along with a brush to effectively remove dust and debris from the surface of the plate. Both sides of the scale were given careful attention during this cleaning process to ensure a thorough cleaning.

The vacuum cleaner played a crucial role in this step as it helped to suction away loose particles from the plate's surface. It effectively removed the larger and more easily dislodged debris, such as loose dirt and dust.

A stiff bristle brush tackled any deeply embedded dust or dirt. The meeting was gently and carefully swept across the plate's surface, working to dislodge and remove stubborn particles. However, it was necessary to exercise caution and use soft bristles on the brush to prevent scratching the delicate glaze layers on the plate while cleaning dirt from crevices or intricate designs.

In addition to the brush and vacuum cleaner, cotton swabs and sponges were used to clean the plate's surface further. These tools provided a more targeted approach, allowing precise cleaning in specific areas. They were handy for cleaning delicate or hard-to-reach spots that required extra care.

The dry-cleaning process effectively removes dust and debris from the ceramic plate's surface by combining a vacuum cleaner, brush, cotton swabs, and sponges. The careful approach ensured that the vessel was thoroughly cleaned without causing any damage to its glaze layers or intricate designs.

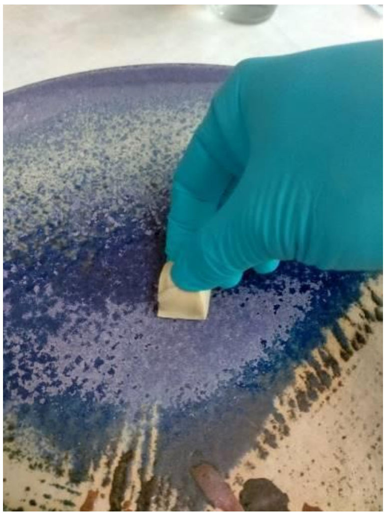


Figure 16 : Using sponges to clean the surface of the plate.

5.2. Wet cleaning

Following the dry-cleaning process, the next step in conserving the ceramic plate involved wet cleaning (Fig. 16). To ensure a comprehensive cleansing of the plate's surface, various solutions, including distilled water, ethanol, and acetone were tested to assess their effectiveness. These solutions were carefully applied to designated areas on the plate using cotton swabs, and the results were meticulously recorded and compared. The testing phase provides valuable information for the conservator to make informed decisions regarding the appropriate cleaning solution. It helps to minimise potential risks and ensure the conservation process is carried out effectively and safely. By documenting and comparing the results, the conservator can select the most suitable solution that achieves the desired cleaning outcome without causing harm to the ceramic plate.

Each test area was marked, and the duration of the tests was closely monitored within specific time limits (Fig. 17). Through the testing process, it was observed that distilled water exhibited effectiveness in removing stains and dust from the plate's surface, including stubborn stains. Ethanol had a weaker effect on stubborn stains and had the potential to alter the colour of the ceramic glaze. On the other hand, acetone

Figure 17: Mapping of the location of test areas.

proved to be equally effective as deionised water in removing stains, dust, and stubborn marks, without compromising the glaze colour of the ceramic. Furthermore, acetone demonstrated a faster cleaning action compared to ethanol.

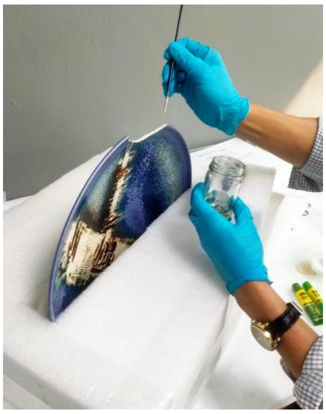


Figure 18: Apply 10% Paraloid B72 in Ethanol before applying UHU glue.

Based on the conducted tests on different areas and parts of the ceramic plate, it was determined that distilled water and acetone exhibited nearly equal efficiency in cleaning. Meanwhile, ethanol showed less effectiveness compared to the other two solutions. When considering the test outcomes, distilled water was the preferred solution for wet cleaning the ceramic plate.

In this test, distilled water is utilised as a cleaning solution, demonstrating superior effectiveness in removing dirt and stains compared to ethanol. It is a neutral substance with a lower potential for health and environmental risks. The chemical properties of distilled water include its high solubility and non-reactive nature, making it suitable for safely cleaning delicate surfaces like ceramic plates.

In contrast, while showing comparable cleaning efficiency, acetone presents a higher heath risk and invironmetal impact due to its volatility and potential hazards.

Considering these factors, the final decision was made due to distilled water's superior effectiveness in removing dirt and stains compared to ethanol, as well as its safer profile in terms of health when compared to acetone.

The wet cleaning process with water involved pouring enough into a small container. A sponge was dampened in the distilled water, ensuring it was not excessively saturated. The damp sponge was used to gently clean the surface of the plate, with particular attention given to areas with stains and dirt. The sponge was periodically rinsed and wrung out to maintain its cleaning efficiency. The process was repeated until the entire plate was thoroughly cleaned. Finally, the dish was left to air dry and gently patted dry with a microfiber cloth.

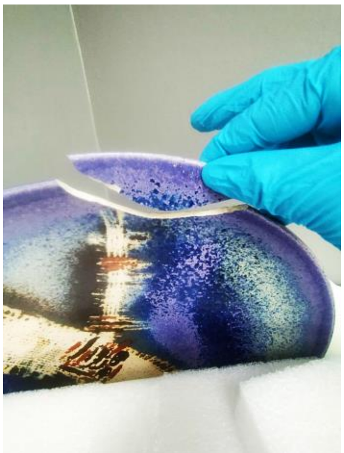


Figure 19 : Reassembling the ceramic part.

The ceramic plate's surface was effectively cleansed using the meticulous wet cleaning method with distilled water while preserving its integrity and appearance. This thorough approach to cleaning ensures the long-term preservation and appreciation of the plate's historical and aesthetic value.

5.3. Gluing broken pieces

The issue of the broken plate section has been resolved by applying UHU adhesive. The glueing process began by using a thin layer of 10% Paraloid B72 in Ethanol on the surface of the shard edge (Fig.18). This thin layer acted as an isolation barrier, preventing the adhesive from profoundly penetrating the ceramic and safeguarding the artwork from potential future damage.

Next, the components from tube A and tube B of the UHU adhesive were mixed to create a homogeneous mixture. This ensured the optimal combination and stability of the adhesive.

Once the adhesive mixture was prepared, it was evenly applied to the broken edges of the plate and the fragmented piece using wooden sticks and other small tools. Applying the adhesive consistently and accurately was crucial to achieve a strong and precise bond between the broken pieces.

After applying the adhesive, the broken parts were manually connected and firmly held together briefly. This allowed sufficient time for the glue to dry and create a secure bond between the fragments (Fig.19).

Following the completion of the glueing process, a meticulous inspection of the ceramic plate's surface was conducted to ensure a seamless bond without any gaps or openings between the fragments. Minor adjustments and refinements were made to achieve a flawless final result if necessary.

During the glueing process, protective measures were implemented to ensure safety, especially when working with adhesives that could emit harmful fumes. Fume extractors were used to remove potentially hazardous vapours and maintain a clean air environment while working with the glue.

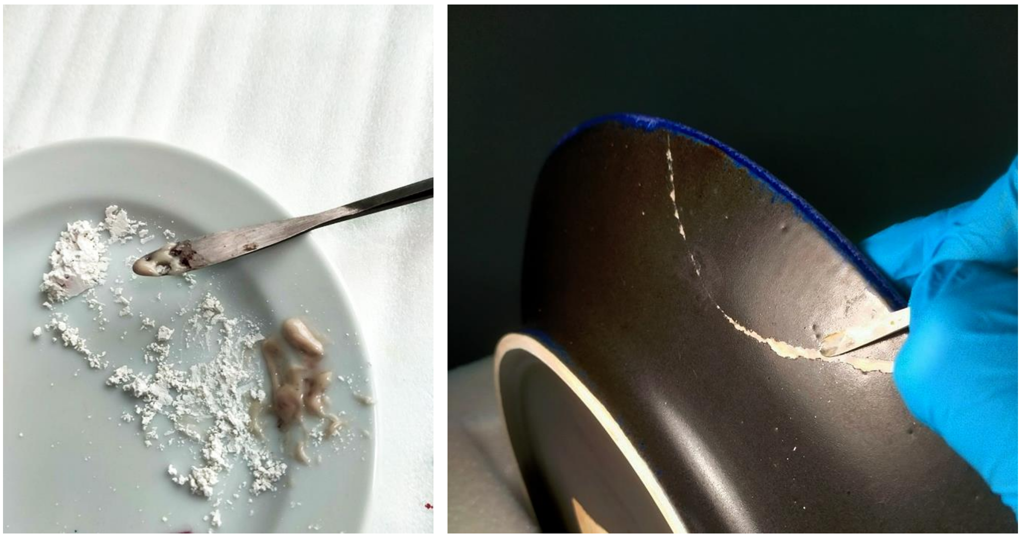


Figure 20 :Mixing the filling material and filling the cracks using a spatula.

In summary, the damaged part of the plate was fixed using UHU Plus Endfest glue. This included applying an isolation layer, combining and putting on the glue, and ensuring the pieces stayed strongly connected. After glueing, the artwork was placed in a controlled environment, and fume extraction systems were used to remove potentially harmful vapours. This ensured safety and protected the health of those involved in the repair process while maintaining a healthy working environment during the adhesive application process.

5.4. Filling cracks

After the conservation and assembly process of the ceramic plate was completed, the next crucial step involved filling the cracks and gaps between the broken pieces. This process served two purposes: enhancing the aesthetic appearance and ensuring the durability of the artefact. To accomplish this, marble powder was selected as the filling material for the cracks and gaps on the plate's surface.

Before proceeding with the filling, a mixture of UHU Plus Endfest glue and marble powder, prepared in the appropriate ratio, was carefully combined. This mixture was thoroughly kneaded to create a thick, well-workable substance. The consistency of the mix was crucial to ensure proper filling and adherence to the plate.

To fill the cracks and gaps on the surface of the plate, various tools such as a spatula, bamboo stick (skewer), and small brushes were utilised (Fig. 20). The choice of tools depended on the size and accessibility of the cracks and gaps. These tools allowed for precise application of the mixture, ensuring it reached all the crevices evenly.

Given the varying depths and widths of the cracks and gaps on the plate's surface, filling the mixture accurately and uniformly was essential to achieve the best possible results. In addition to serving the shots, if there were any missing glaze or material on the plate's surface, the mixture was applied to compensate for these areas and create a more even surface.

After the filling process, waiting for the glue and marble powder mixture to dry completely was necessary. This drying time allowed for forming a solid bond and ensured the stability of the filled areas. Once the mixture had dried, a scalpel blade was employed to carefully remove any excess adhesive that may have seeped onto the surface of the plate. This step helped achieve a clean appearance.

Furthermore, sandpaper was utilised to smooth out excess material and create a matching surface. This sanding process required precision and care to achieve a smooth, levelled surface like the rest of the plate.

In summary, it fills the cracks and gaps by preparing a mixture of UHU glue and marble powder, accurately applying it using various tools, allowing it to dry completely, and subsequently removing excess adhesive and smoothing the filled areas with sandpaper. This comprehensive approach aimed to restore the aesthetic integrity of the ceramic plate and ensure its long-term stability.

Figure 21 :Test colours before retouching.

5.5. Retouching

Returning the ceramic plate was a complex task requiring extensive knowledge and meticulous care to preserve the original piece's integrity and value. The choice of materials and techniques, as well as the execution of the retouching process, played a role in achieving a successful restoration while honouring the unique character and aesthetic beauty of the artwork.

After thorough consideration, it was determined that acrylic colours would be the most suitable material for the retouching process (Fig. 21). Acrylic colours offer a wide range of vibrant hues and excellent colour stability, making them ideal for replicating the original colours and patterns of the ceramic plate. The retouching process began by using a fine brush to carefully apply the acrylic colours to the cracks and holes on the plate.

In addition to filling the cracks and holes, attention was given to imitating the glaze. A thin stick, such as a toothpick or skewer, was delicately used to dab dots of acrylic colour onto the plate. These dots were applied with equivalent thickness and colour to that of the original glaze, creating an illusion of continuity and ensuring a seamless blend between the retouched areas and the surrounding surface (Fig. 22).

Any excess acrylic colour or unevenness resulting from the retouching process was gently smoothed to achieve a smooth and consistent surface using fine-grit sandpaper. This step required precision and a delicate touch to avoid damaging the ceramic glaze and altering the original characteristics of the plate. The retouching process required extraordinary attention to detail and an understanding of the specific properties of the plate material. The objective was to integrate the retouched sections with the plate's original colours, achieving a well-balanced visual effect.

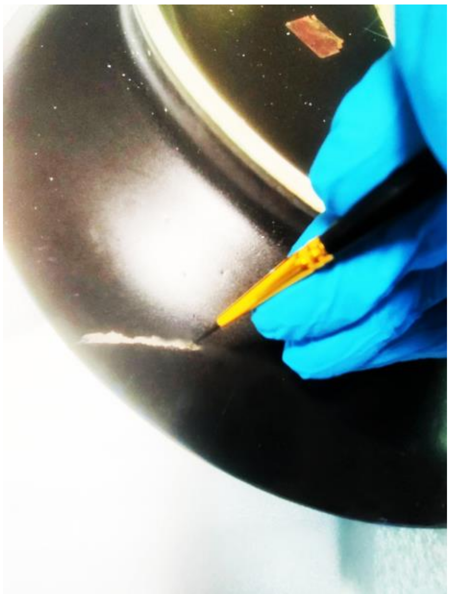


Figure 22: Using acrylic colour with a small brush for retouching the plate.

Once the retouching process was completed, allowing sufficient time for the acrylic colours to dry completely before proceeding with the preservation and display stages was crucial. This ensured that the retouched areas were optimistic.

During the retouching process, an idea was discovered: restoring the missing material holes without additional retouching on the surface of the plate. Instead of using acrylic paint for colour matching, a combination of marble powder and UHU glue was employed. This mixture resulted in a homogeneous, opaque white colour that harmonised with the original decorations of the ceramic plate. The filled areas bear a striking resemblance to the original, eliminating the need for additional retouching.

In conclusion, retouching the plate was a meticulous process that demanded knowledge and expertise. The careful selection of materials, precise execution of techniques, and a profound understanding of the original piece characteristics are vital to achieving a successful restoration while preserving the integrity and aesthetic value of the ceramic plate.

6. Suggestions for storage and display

Proper storage and display are crucial for preserving the restored ceramic plate's condition, aesthetics, and longevity. The following recommendations provide a comprehensive approach to ensure its protection and enhance its visual appeal:

Cleaning and Maintenance: Regular dusting using a soft, lint-free cloth or a soft brush helps maintain the plate's appearance. It is essential to avoid using water or harsh cleaning agents unless recommended by a professional conservator, as they can potentially damage the surface or remove the applied protective coatings.

Display Case Selection: When considering the plate, there is a range of potential crafting materials. Boxes can be crafted from diverse materials, each with unique qualities, such as wood, acrylic or museum-grade glass, which are resistant to chemical reactions that could harm the ceramic. The case should be adequately sealed to prevent dust and pests from entering while allowing for proper ventilation. In the case of the plate, foam was selected for use.

Environmental Considerations: The storage location should maintain a stable and controlled climate. Avoid areas with extreme temperature and humidity fluctuations, as they can cause expansion and contraction of the ceramic, leading to cracks or damage. Additionally, it will be necessary to protect the ceramic plate from direct sunlight, which can fade colours and degrade the materials over time.

Handling and Care: Gloves are recommended when handling the ceramic plate to prevent oils and fingerprints from transferring onto the surface. The scale is adequately supported from the bottom to avoid placing stress on fragile areas. Furthermore, keeping the plate away from potential sources of vibrations is recommended to prevent accidental damage.

Lighting Considerations: Lighting plays a significant role in the display of ceramics. Incorporating lighting systems inside display cases should be avoided to prevent heat-related issues. Use lights with low UV levels and high colour rendering indices (>90) to accurately showcase the true colours of objects. One important consideration is to employ lighting arrangements that facilitate easy maintenance and control of light levels. Moreover, light levels should be set within a case based on the sensitivity of the most light-sensitive object in the display.[26]

Rotation and Display Management: To prevent uneven fading or wear, periodically rotate the displayed ceramic plate. This ensures equal exposure to light and reduces the risk of certain areas becoming more vulnerable to deterioration over time. Proper documentation of the rotation schedule is essential for maintaining the plate's condition and managing its display.

Supportive Display Surface: Whether placed on a shelf or inside a display case, the surface on which the ceramic plate rests should be stable and well-supported. Consider using a cushioning material, such as soft padding or fabric, to provide a protective layer and minimise any potential scratching or shifting of the plate.

Following these guidelines can safeguard the restored plate, ensuring its longevity, preservation, and aesthetic value. Proper storage and display practices contribute to the plate's overall appreciation, allowing it to be appreciated by present and future generations.

PE Foam (Polyethylene Foam) was employed as a thermal and acoustic insulation material made from polyethene. Its box is implemented throughout the preservation process and is intended to be maintained during storage to ensure the safety of the plate. This measure was adopted to shield the plate from temperature variations and reduce potential external influences, ensuring extended preservation and safety. The first step involved designing and creating a custom-sized protective box using PE Foam, providing optimal protection for the ceramic plate (Fig.23).

Figure 23: Securing the plate with PE foam box during the gluing process.

[26] S. Anstey, M. Myers and I. M. Godfrey. "Handling, Packing and Storage", Western Australia Museum. 24-26 pages.

Within the box, a carefully tailored section was crafted to match the shape and dimensions of the ceramic plate perfectly. This section was constructed with PE Foam, incorporating slots to hold and stabilise the vessel securely. Using PE Foam as a soft and non-damaging cushioning material, the dish was effectively shielded from potential impacts and deformation during transportation and storage.

To prevent any undesired movement or sliding within the box, strips and small pieces of Pe Foam were cut and strategically placed to secure the plate in position firmly. This approach guaranteed the plate stability, minimising the risk of collisions or shifting during handling and storage procedures.

The box was appropriately labelled for enhanced identification, allowing for quick recognition of its contents. Using Pe Foam as the primary material in the construction of the storage box, the restored ceramic plate was safeguarded and preserved with care, shielding it from any potential harm and maintaining it over an extended period.

7. Glues for different ceramic materials in Southeast Asia

Various adhesives are currently used to conserve ceramic artefacts in Southeast Asia countries, focus in Thailand and Vietnam. In Southeast Asia, numerous adhesive options exist, including Epoxy Resin, animal glue, Polyvinyl Acetate (PVA) glue, Acrylic resin, Silicone glue, and Tapioca glue, modifiers and reinforcing agents, along with other adhesive varieties, are also considered and commonly used.

In the practice of conservation units in Southeast Asia today, Epoxy resin has become the preferred choice at museums, archives, and archaeological institutes for conserving ceramic works. Its advantages, including exceptional durability, color adaptability, resistance to water and chemicals, versatility across various ceramic materials, and ease of use, make it the preferred adhesive for meeting the demands of the Southeast Asian market, especially in the current ceramic conservation efforts.The versatility of epoxy resin enables it to bond with various materials, such as wood, ceramic, plastic, ivory, and others. For preserving ceramic artefacts, it is crucial to ensure the artefact's safety after bonding and the adhesive's ability to adhere without causing harm to exposed areas.

In theory, epoxy resin should perform well with all kind of ceramic materials. This was also the reason why epoxy was selected for conserving the plate of the thesis. However, epoxy resin is available under multiple brands in the Asian markets. Thus, choosing the appropriate adhesive brand is essential for the conservator. Moreover, determining the specific extent of application as well as the advantages and limitations of epoxy adhesive on each type of ceramic, including terracotta, earthenware, stoneware, and porcelain, is an essential issue.

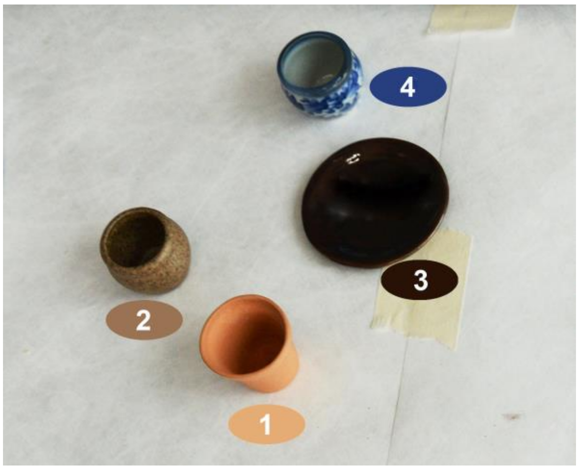


Figure 24: Test samples:
1. Terracotta; 2. Earthenware; 3. Stoneware; 4. Porcelain.

To precisely determine which epoxy brand is suitable for conserving the plate and to facilitate application, a series of tests for evaluation are being conducted. This ensures that the results can also be applied in the future.

In the context of this study, object testing mockups were selected based on their firing temperatures and categorised according to the traditional production standards of Asian and Thai ceramics. The four types of ceramics chosen for analysis were terracotta, earthenware, stoneware, and porcelain (Fig.24).

7.1. Terracotta

Terracotta is a ceramic material that undergoes firing at temperatures ranging from 600°C to 900°C. This firing process gives terracotta its distinctive characteristics. Terracotta ceramics are relatively porous structure compared to other ceramics, often unglazed.

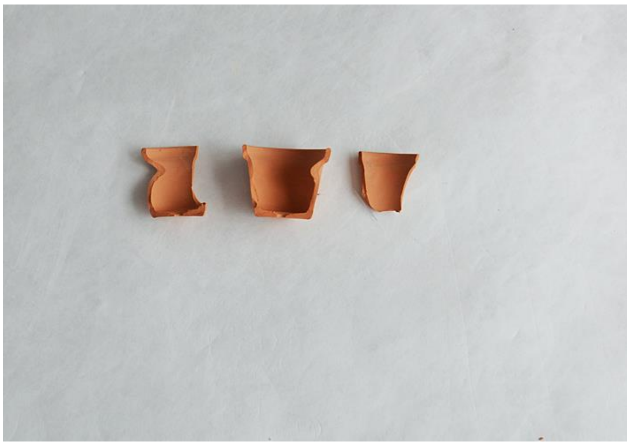


Figure 25: Terracotta samples were tested.

Terracotta is known for its distinct reddish-brown colour, which results from the iron content in the clay. It is commonly used in pottery, sculptures, architectural ornaments, and building materials (Fig.25).

One notable characteristic of terracotta is its high porosity. The material has a significant amount of tiny pores, which allows for increased moisture absorption and evaporation. While this can be advantageous in specific applications, such as in pottery or architectural elements and pots, it also makes terracotta more susceptible to damage when exposed to external forces. Due toits porosity, terracotta can easily break or crack under pressure or impact.[27]

[27] Philippe Boch, Jean-Claude Nièpce, 2007.

7.2. Earthenware

Figure 26 : Earthenware samples for test.

Earthenware is a ceramic material fired at temperatures ranging from 900 to 1230°C (Fig.26). Compared to terracotta, earthenware has a more complex structure. It can be either glazed or unglazed, and when glazed, it may have a single colour or a decorative pattern.[28]

The ceramic body of earthenware is generally smoother than terracotta, although it can still contain impurities. The firing process at higher temperatures gives earthenware a denser texture. However, it is essential to note that earthenware is still relatively porous compared to other types of ceramics, such as stoneware or porcelain.[29]

One characteristic of earthenware is its lower water absorption capacity compared to terracotta. The fired clay body of pottery is less porous, which means it absorbs less moisture. This quality makes it suitable for functional items like tableware or cookware. However, the lower firing temperature of earthenware also makes it more susceptible to breakage when subjected to external forces. It is generally less durable and more prone to chipping or cracking than ceramics fired at higher temperatures.

Despite its limitations, earthenware is widely used and appreciated for its affordability, versatility, and aesthetic appeal. Its smooth surface and potential for vibrant glazes make it a popular choice for pottery, tiles, and decorative objects.

7.3. Stoneware

Stoneware is a type of ceramic material that is fired at temperatures between 1120°C

[28] Philippe Boch, Jean-Claude Nièpce, 2007

[29] *Ceramic classification differs between Europe and Asia. In Asian studies, Terracotta, Pottery, Ceramic, and Porcelain are classified as Earthenware, Stoneware, Porcelain, and Porcelain Stoneware, respectively, in European literature. Firing temperatures also vary. Further references are recommended for a comprehensive understanding.*

and 1300°C. Compared to terracotta and earthenware, stoneware undergoes bisque and glaze firing, resulting in a dense, complex, and durable structure.[30]

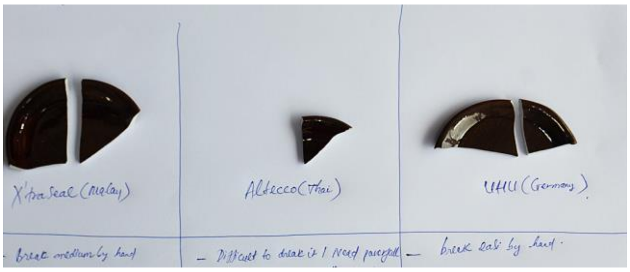


Figure 27: Stoneware (also Porcelain stoneware) samples for test.

Stoneware ceramics have a smooth ceramic body with fewer impurities compared to earthenware. The higher firing temperatures eliminate much of the porosity, making stoneware less absorbent and more water-resistant. This characteristic makes stoneware suitable for functional items like dinnerware, baking dishes, and pottery that require a higher level of durability and resistance to staining (Fig. 27).

In terms of appearance, stoneware can be single-coloured or multi-coloured. It is often glazed, which adds a layer of protection. The glaze can range from glossy to matte, providing various textures and finishes.

Compared to terracotta and earthenware, stoneware has a better load-bearing capacity and is more resistant to external forces. It is less prone to breakage or chipping, making it suitable for everyday use and handling.

Overall, stoneware offers a balance between durability, functionality, and aesthetic appeal. Its smoother body, refined structure, and resistance to external forces make it popular for various ceramic applications.

[30] Philippe Boch, Jean-Claude Nièpce, 2007, 110-117 pages.

7.4. Porcelain

Porcelain is a type of ceramic material that is fired at temperatures exceeding 1200°C. It has a rigid structure, and its surface is covered with multiple glaze colours. Porcelain undergoes a specific firing process, typically involving two firings at different temperatures.

Figure 28: Porcelain samples for test.

The first firing, known as the biscuit firing, happens at a heat level suitable for ceramic materials, typically around 1350°C. This initial firing gives the porcelain its rigid and durable structure. After the biscuit firing, the porcelain is glazed, decorated, and undergoes a second firing at a higher temperature of over 1430°C (Fig. 28). This high firing temperature further vitrifies the porcelain, resulting in its characteristic translucent and glass-like appearance.[31]

During this high-temperature firing, the glaze on the surface of the porcelain undergoes a process called vitrification. Vitrification refers to transforming a material into a glassy, non-crystalline state due to its components' melting and subsequent rapid cooling. As the glaze melts and rapidly solidifies, it forms a smooth, reflective surface that enhances the porcelain's lustrous and delicate quality.

[31] (John N. Miksic, Geok Yian Goh (2019).

7.5. Test series on different methods and materials

7.5.1. Materials testing

The concept of conducting a test series on different methods for gluing ceramics involves evaluating and comparing various adhesives and techniques to determine the most effective material. Factors such as bonding strength, durability, compatibility, and ease of application are assessed and application are evaluated. The testing uses manual hand force and temperature assessment with an infrared lamp to assess the quality of the epoxy adhesive's components. The results guide the selection of the optimal adhesive for successful and long-lasting bonding.

Therefore, the first criterion is determining an appropriate sealant for the ceramic

Figure 29: Names of epoxy adhesives: 1. Alteco; 2. X'traseal; 3. UHU Plus Endfest

material. To accomplish this, three types of epoxy adhesives were prepared: Alteco produced in Thailand; X'traseal in Malaysia, and UHU Plus Endfest produced in Germany[32] (Fig. 29).

All the essential materials for the conservation of ceramics have been prepared. In addition to the testing samples and adhesive varieties, other materials such as Acetone,

[32]1. Alteco glue is suitable for bonding wood, rubber, plastic, metal, ceramic, and clay. Alteco datasheet. *https://www.alteco.co.jp/cms/wp-content/uploads/catalog/cyanoacrylate_English.pdf*

2. X'traseal glue works well on both porous and non-porous materials. The adhesive can bond most metal, wood, rubbers, plastics, leather, ceramics, glass and fabric. Datasheet of X'traseal glue *https://www.xtraseal.com/tds/5269619049TDS%20-%20Super%20Glue.pdf*

3. UHU, the all-purpose adhesive, exhibits excellent strength on metals, wood, paper, textiles, and leather. It is also very suitable for bonding materials such as glass, ceramic, and Plexiglas—datasheet of UHU glue. *https://static.rapidonline.com/pdf/87-2458.pdf*

Ethanol, and Paraloid BB72, are also on hand. Paraloid BB72 serves as an isolation layer applied before bonding fragments, ensuring optimal results.

The testing process involved breaking and gluing test samples of stoneware, porcelain, terracotta, and earthenware to assess the suitability of different adhesives for each material. The influence of epoxy on each type of ceramic was also evaluated. The test encompassed the initial and subsequent adhesive bonding capabilities, their effects on the mechanical properties of ceramics, such as hardness and durability, the stability of the bond under different temperatures and environmental conditions, and potential chemical impacts between glue and ceramic materials. This analysis helped ascertain the suitability of epoxy adhesives for bonding the ceramic types.

Two-component bonding systems are used to test the adhesives, with tubes A and B containing specific quantities of glue that were mixed to form a homogeneous mixture. The substance is applied to the broken pieces, ensuring an even surface distribution. Proper hand movements and application techniques are emphasised to achieve a high-quality patch. Working quickly before the glue dries is crucial to maintain its adhesive strength. Fume extractors ensure a safe working environment by removing potentially harmful vapours.

To ensure optimal results, each type of adhesive was tested twice on the same ceramic material (Figs. 9.1 and 9.4.). This involved the initial bonding process, followed by applying sufficient force to remove the patch after 24 hours to evaluate the adhesive's bonding strength and impact on the patched area.

The procedure was repeated in the second test to assess the condition of the adhesive's contact surface compared to the initial bonding. In addition, factors such as the interaction between the cement and the ceramic material, the adhesive's permeability, and the potential consequences of deep penetration into the ceramic structure were also evaluated.

7.5.2. The test results

After two weeks of experimenting with various adhesive types on the mockups, the results are discussed and documented as follows:

Alteco adhesive is highly effective, as it firmly bonds broken pieces together, creating a durable, solid bond that is difficult to break. However, this adhesive penetrates the ceramic system deeply, resulting in a complex and brittle contact surface. When attempting to remove and reattach the broken piece for the second time, the adhesion power was not as good as the first time.

Alteco adhesive is not affected by temperatures over 40°C applied with an infrared lamp; the repaired pieces remain intact without separating (Fig. 30 and 31).

X'traseal adhesive effectively bonded the broken pieces together. It forms a solid and durable structure that is hard to break. However, removing the old adhesive residue was

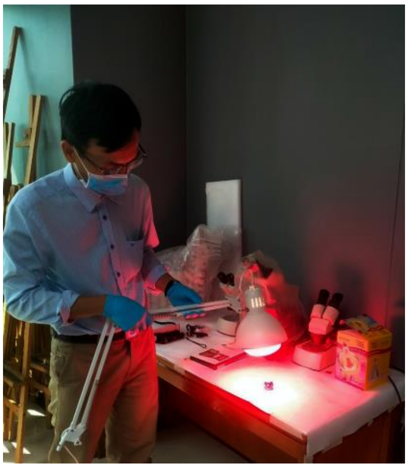


Figure 30 & Figure 31: types was tested using force and infrared light.

more challenging than the Alteco adhesive. The ability to bond broken pieces for a second time was almost nonexistent due to the rough, hard, dry, and roughened contact surfaces that resulted from the first application on the ceramic. The adhesion is minimal. When using an infrared lamp at 40°C, X'traseal adhesive still performs well and maintains a good bond.

UHU Plus Endfest adhesive demonstrated good bonding ability, with broken pieces sticking tightly together and creating a solid, durable structure that is hard to break. Unlike Alteco and X'traseal adhesives, UHU adhesive does not penetrate deeply into the ceramic body, keeping the contact surface flexible and resilient.

During the conservation process using UHU, if any issues arise during restoration, reapplication of adhesive becomes necessary. For cleaning off UHU adhesive residues, acetone can be used, ensuring preservation of the surface structure without damage.

Figure 32 : UHU adhesive is chosen for gluing the broken pieces.

The broken pieces can be effectively reattached for a second time, as the contact surfaces remain largely unaffected when using this adhesive.

When using an infrared lamp at 40°C, the broken ceramic pieces can be loosened without applying much force. The contact surfaces with the adhesive remain largely unaffected, and the ability to bond the pieces again is still good, similar to the first application.

Due to its notable advantages, UHU Plus Endfest was selected for gluing the ceramic plate fragment. Its strong bonding ability securely holds the broken pieces together, creating a durable and resilient bond that is highly resistant to breakage (Fig.32). Unlike other adhesives such as Alteco and X'traseal, UHU glue does not deeply penetrate the ceramic structure, minimising the risk of damage to the artefact. Furthermore, the joined pieces maintain a soft surface after gluing UHU glue, reducing their brittleness and susceptibility to breakage.

Additionally, UHU is non-destructive to the surface of the bonded material. Consequently, even after fragments have been removed and re-adhered multiple times, the surface of the fragments remains securely bonded, thanks to its strong bonding properties. Another significant advantage of UHU is its eco-friendliness. Compared To other tested adhesives, UHU glue demonstrates superior environmental protection capabilities. It is odourless and safer for users compared to Altexco and X'traseal. Moreover, UHU is easily cleaned up using acetone.

The material testing results highlight the outstanding features of UHU glue, including its robust bonding capability, minimal impact on the structural integrity of the artefact, pliable surface after application, reusability, and eco-friendliness. Although it requires a longer curing time, the intense bonding ability of UHU compensates for the wait, ensuring the artefact remains securely and durably attached.

The test results also indicated that applying epoxy adhesive on terracotta and earthenware can have drawbacks. The glue seeped into the terracotta and earthenware materials, resulting in brittleness and breakage. Therefore, when using epoxy resin adhesive on ceramics such as terracotta and earthenware products, caution is advised.

Figure 33:The residues from Altaco and X'traseal penetrate deep into the terracotta's structure.

7.5.3. Risk of epoxy resin on ceramic materials

As far as mentioned, epoxy glue is not considered fully reversible. Unlike other adhesive options, epoxy bonds are often difficult to reverse without causing damage to the original materials. The disadvantages of epoxy adhesives on ceramic materials have been identified throughout the experimental process.

This is an essential factor to consider in conservation efforts, as the preference is typically for reversible and minimally invasive interventions to ensure the long-term conservation of cultural heritage objects, including ceramics.

Through the test, this analysis examines the utilisation of epoxy adhesive on ceramic materials, particularly terracotta and earthenware, and the associated risks.

When epoxy adhesive is used on terracotta, the adhesive tends to penetrate deep into the ceramic body. Initially, the bonding effect may be satisfactory, but after approximately three months, adverse effects become evident. Wet, fine lines showing the glue bonded cracks. Additionally, when the adhesive is removed for inspection, the terracotta becomes brittle, crumbly, and powdery due to the intrusion of the adhesive (Fig. 33). The area where the glue was applied becomes prone to breakage upon impact and cannot be re-bonded.

When epoxy adhesive is used on earthenware, the penetration of glue into the ceramic body is less compared to terracotta. However, the bond still penetrates the material, making it brittle and crumbly. If the broken piece falls apart, it cannot be re-bonded.

Exercise caution when using epoxy resins to bond terracotta and earthenware objects with low firing temperatures. Testing reveals that epoxy resin can harm and weaken the structure of these materials.

Figure 34: Risks of UHU glue on Terracotta sample.

Understanding the risks associated with epoxy glue on terracotta and earthenware material objects will assist conservators and curators in making more informed decisions when conserving ceramic materials under specific conditions.

In conclusion, using epoxy adhesive on terracotta and earthenware can lead to negative consequences such as adhesive seepage, brittleness, and irreparable damage. Thorough attention should be devoted to selecting the appropriate adhesive for each type of ceramic artefact material. A clear understanding of the risks associated with epoxy resin is crucial for enhancing conservation and restoration methods for ceramic objects.

Summary

The process of plate conservation began with a comprehensive investigate and analysis of the ceramic material. This involved thoroughly examining the characteristics and properties of various types of ceramics, including terracotta, earthenware, stoneware, and porcelain. A solid comprehension of the material allows researchers to develop appropriate conservation methods and materials.

After the material analysis, the object's condition was assessed. This involved carefully evaluating its properties and identifying damages, as cracks, or fragments. This detailed examination gives an overall understanding of the object's condition, enabling the Formulation of the condition concept.

Subsequently, extensive testing and research on the adhesive materials used in the following restoration process became crucial. Identifying and experimenting with different types of adhesives were essential to find the most suitable one for each ceramic material. Factors such as strength, bonding ability, aesthetic considerations, and long-term preservation have been carefully evaluated during this process.

Research and testing can determine the appropriate adhesive for ceramic conservation work. This ensures effective restoration while preserving the ceramic object's cultural significance and heritage value.

Finally, proper storage and display condition are suggested. It includes that the object is stored in an appropriate environment, shielded from direct sunlight and fluctuations in temperature and humidity. Additionally, careful consideration is given to the method to ensure the ceramic object's safe and aesthetic presentation.

In summary, the process of research and conservation encompasses material analysis, condition assessment, adhesive testing and selection, and proper storage and display practices. The ultimate objective of this process is to preserve and protect the cultural values of the ceramic object in the long term. Furthermore, the research findings from this thesis can be applied to the conservation of other ceramic collections, particularly those facing preservation challenges in the Southeast Asia region. In preserving ceramic artefacts, especially in Southeast Asia. More research in this region needs to be conducted concerning how epoxy resin affects ceramic objects

Appendix:

Appendix I Photo documentation

Figure 36: Loss of part.

Figure 35: Residues on the plate.

Figure 38: Broken part and fragments of the plate.

Figure 37 :Fragments of the plate.

Appendix II Condition survey

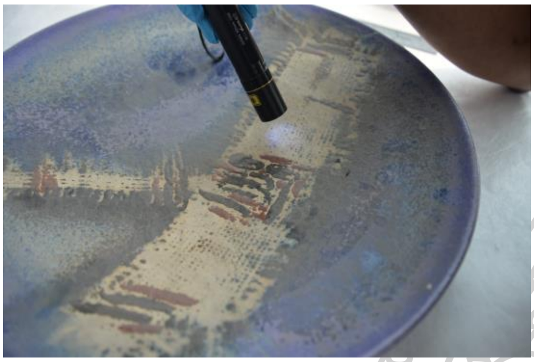


Figure 39: Checking on surface of the plate by UV light.

Figure 40 :Measuring the broken piece of the plate.

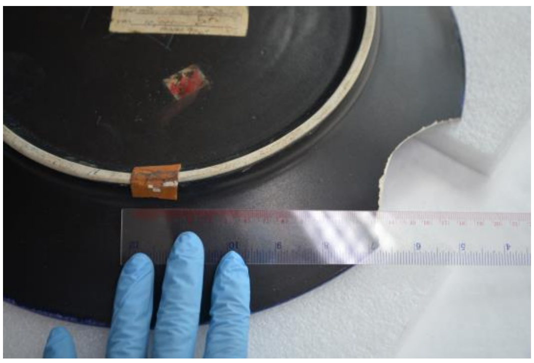


Figure 42: Checking the residures before conservation.

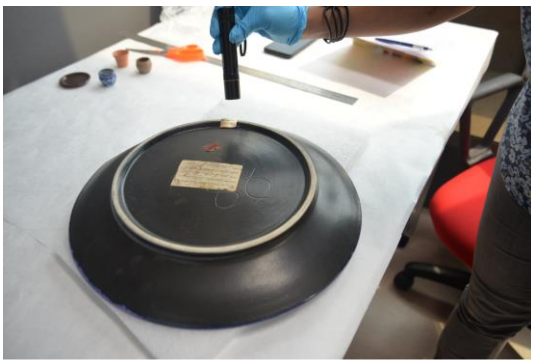


Figure 41 : Analysis residures and deposits on the back of the plate.

Appendix II Mapping

Figure 43 : Mapping of the location of test areas for wet cleaning.

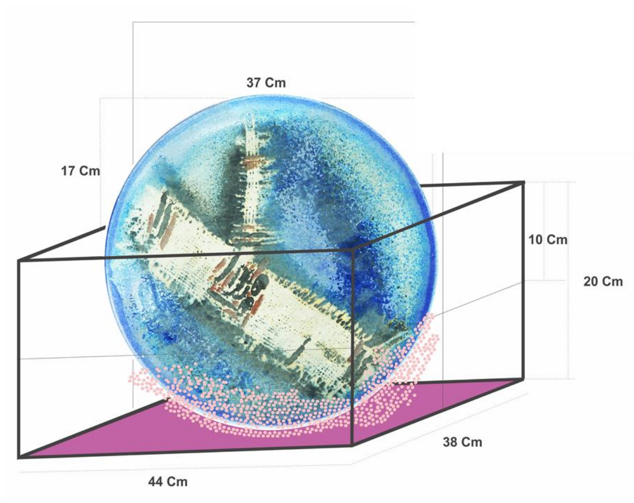


Figure 44: Mapping the stable placement of the plate during the conservation process.

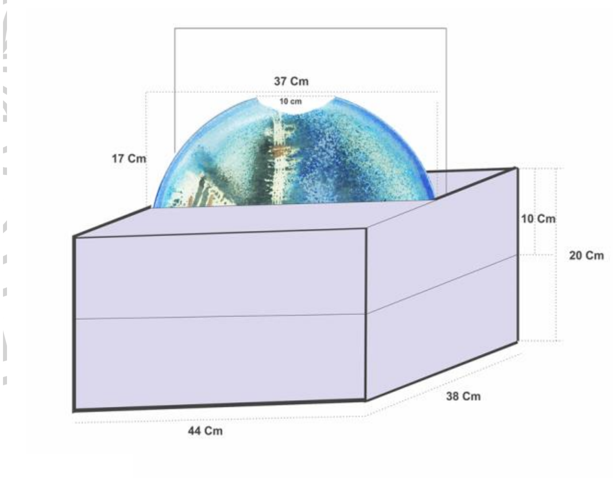
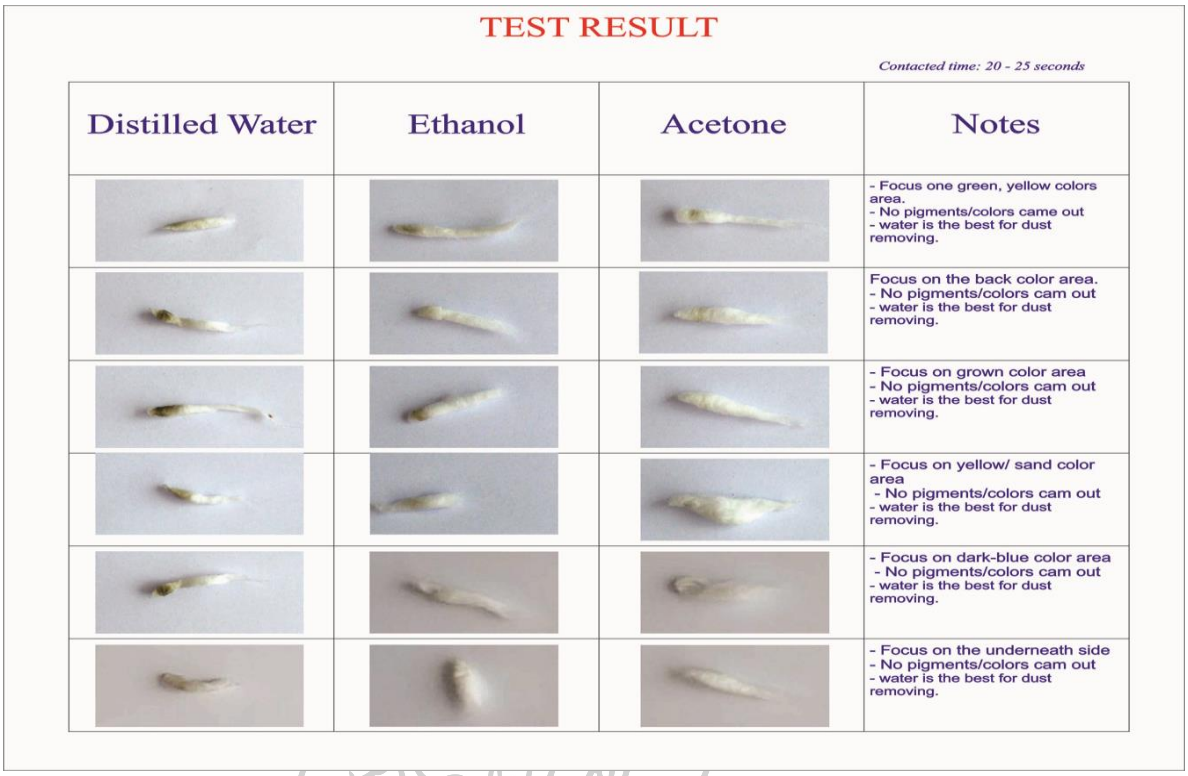


Figure 45: Mapping for storing and display.



TEST RESULT

Contacted time: 20 - 25 seconds

Distilled Water	Ethanol	Acetone	Notes
			- Focus one green, yellow colors area. - No pigments/colors came out - water is the best for dust removing.
			Focus on the back color area. - No pigments/colors cam out - water is the best for dust removing.
			- Focus on grown color area - No pigments/colors cam out - water is the best for dust removing.
			- Focus on yellow/ sand color area - No pigments/colors cam out - water is the best for dust removing.
			- Focus on dark-blue color area - No pigments/colors cam out - water is the best for dust removing.
			- Focus on the underneath side - No pigments/colors cam out - water is the best for dust removing.

Figure 46 :Table shows the test results of wet cleaning.

No	Contents	Notes
1	Test name adhesives: 1. Alteco glue of Thailand 2. X'traseal glue of Malaysia 3. UHU Plus Endfest of Germany	
2	Test samples: 1. Terracotta 2. Earthenware 3. Stoneware (Porcelain Stoneware) 4. Porcelain	

Figure 47: Table displays the adhesive names and test samples for gluing.

Materials	Type of glues	Number of tests	Exposure time
Terracotta	Alteco, X'traseal, UHU	3	24 hours
Earthenware	Alteco,X'traseal, UHU	3	24hours
Stoneware	Alteco,X'traseal, UHU	6	24hours
Porcelain	Alteco,X'traseal, UHU	6	24 hours
4	3	18	15 days/18 tests

Figure 48 :Table of duration and frequency summary.

Appendix III Imaging the conservation process

Figure 49: Use vacuum cleaner and brush for dry cleaning.

Figure 50 :Testing solvents before wet cleaning application.

Figure 52:UHU glues and Paraloid B72 for bonding the broken part.

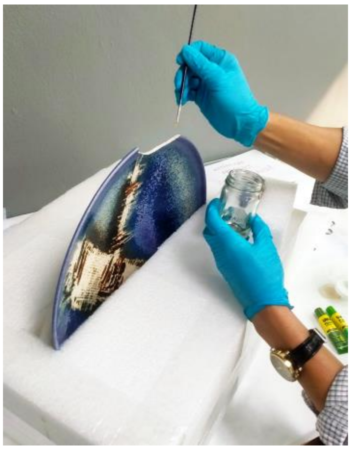


Figure 51 : Apply 10% Paraloid B72 in Ethanol before applying UHU glue.

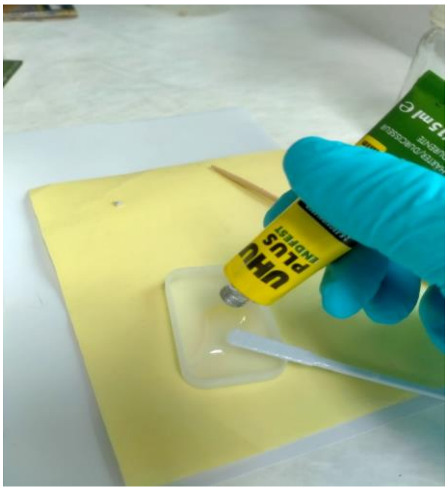


Figure 54:UHU Glue Mixture for Conservation

Figure 53: Reassembling the part of the plate.

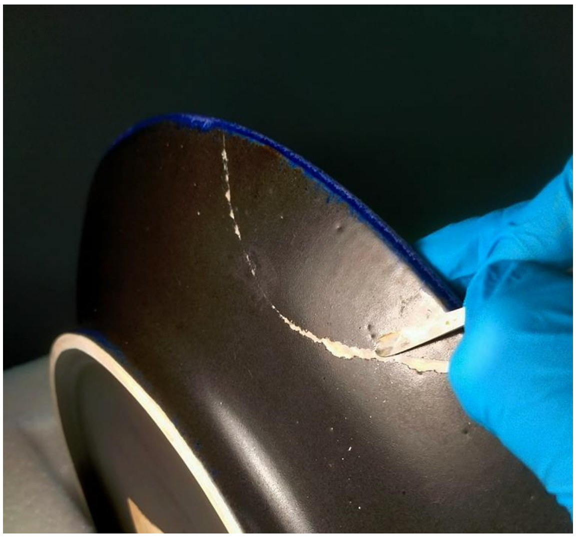


Figure 55, Figure 56: Mixing the filling material and filling the cracks using a spatula.

Figure 57, Figure 58 :Before conservation

Figure 59, Figure 60 :After conservation

Appendix V Product data sheets

X'traseal adhesive data sheet

TECHNICAL DATA SHEET
REV: 05 DATE: 04 FEB 2020

x'traseal®

4 MINS STEEL EPOXY

DESCRIPTION:
x'traseal® 4 MINUTES STEEL EPOXY is steel filled fast setting gray color epoxy adhesive. It offers good gap-filling capabilities and slumping characteristics. It has temperatures resistance up to 120°C and is pressure resistant. It is very useful for emergency repairs in industries, workshops, marine, automotive, construction and also for household use. After cured, it can be drilled, sanded, and painted. It contains no solvent or VOC, not flammable and no shrinkage after cure.

FEATURES:
- Paintable.
- Non shrinkage.
- Steam and heat resistance.
- Fast setting within 4 minutes.
- Easy to use, one to one mixing ratio.
- Strong bonding strength when hardened.
- Water, solvent, acid and alkaline resistance.
- Can be sanded, filed, drilled, tapped or threaded when hardened.

USES:
- Permanent repair: Leaks, holes, cracks, mounting signs to walls.
- Suitable Substrates: Metal, fiberglass, concrete, ceramics and some plastic materials.

NOT RECOMMENDED FOR:
PE, PP and PTFE.

APPLICATION:
- Puncture the tube with the cap and squeeze out equal amount of resin and hardener.
- Mix homogenously until mixture gets uniform color.
- Apply it on clean surface within 3minutes.
- For best adhesion roughen the surface.
- Replace cap after use and store in cool, dry place.

SPECIFICATION:

Color, Resin Hardener	 Black White
Specific gravity, Resin Hardener	 1.77±0.04 g/ml 1.54±0.05 g/ml
Viscosity, Resin Hardener	 306.5±96.5K cps 92.5±37.5K cps
Mixing ratio, A:B	 1:1
Appearance	Paste form
Work Life (Minutes at 25°C)	3 - 4
Curing time (Minutes at 25°C)	4 - 5
Hardness (Shore D)	Minimum 80
Temperature limits	15°C to 120°C
Nonvolatile Content	100%
Lap Shear Strength (kg/cm^2)	Minimum 90
Shelf Life	24 Months(1)

STORAGE:
(1)Shelf life is subjected to change due to the type of packaging used and the condition of the environment. Material should be stored in a dry and cool place between +5°C to +30°C.

CAUTION:
Normally, while mixing by hand it does not cause any skin irritation, but in some cases with sensitive skins, it may cause irritation or sensitization. In such cases, wash the hands with plenty of water and soap and use hand gloves for application.

This information is provided in good faith and is believed accurate based on a review of current composition and information supplied by vendors. No warranty is expressed or implied.

WE RECOMMEND PRELIMINARY COMPATIBILTY TESTS PRIOR TO APPLICATION TO ACHIEVE DESIRABLE RESULTS

MOHM CHEMICAL SDN. BHD. (REG NO 276851-J)
No.32, Jalan Temenggong, Off Jalan Tampoi, 81100 Johor Bahru, Johor Darul Takzim, Malaysia.
Tel : +607 333 1222 Fax : +607 332 0545 / 333 7919

Page **1** of **1**

Website: www.xtraseal.com Email : info@mochem.com

UHU Plus Endfest 300 adhesive

45738 - UHU PLUS ENDFEST 300 DOUBLE SYRINGE 50 ML DE - 45735

UHU® PLUS ENDFEST 300

EXTREMELY STRONG, UNIVERSAL, SOLVENT-FREE, DUAL-COMPONENT EPOXY ADHESIVE

PRODUCT DESCRIPTION

Extremely strong, universal, solvent-free, dual-component epoxy adhesive.

FIELD OF APPLICATION

Suitable for bonding metal, stone, concrete, porcelain, wood, glass, many synthetics. Ideal for (industrial) joints, which must meet the highest requirements, such as in electrical engineering, metalworking and automation. Not suitable for bonding of PE, PP, PTFE, polystyrene and soft PVC.

PROPERTIES

- Extremely high final bond strength (300 kg/cm²)
- Extremely loadable
- Shockproof
- Filling
- Water resistant
- All-weather resistant
- Solvent-free
- Resistant to many solvents, diluted acids and alkalis
- Can be sanded, filed, drilled and painted after curing
- Provided with UL approval

PREPARATION

Working conditions: Only use at temperatures between +15°C and +25°C and with maximum relative humidity of 65%. To prevent the formation of bubbles by condensatin, the temperature of the adhesive and materials to be bonded should be the same as the ambient temperature and preferably between +18°C and +20°C. Process in a draft-free space.

Temperatures below +18°C slow down the curing process and result in less bonding strength. Additional heat (heater, infrared heater, or similar) is necessary for processing in cold conditions and in open air. Higher final bond strength is achieved when the curing process takes place at high temperatures up to a max. 180°C).

Personal safety: It is recommended that rubber or plastic gloves are worn.

Surface requirements: The materials to be bonded must be dry, clean free of grease.

Preliminary surface treatment: Thoroughly clean surfaces before bonding, for example, with acetone. Depending on the surface, roughen the parts to be bonded with, for example, Griffon scouring fibre or Griffon emery cloth.

Tools: Plus Gun en Plus static mixers.

APPLICATION

Mixture ratio: 1:1 (by volume)

Place the double syringe in the Plus Gun. Remove the cap of the double syringe. Press both components from both chambers and then place the Plus Static mixer. Apply the adhesive to rough materials on both sides, to smooth materials on one side. Next add materials together and fixate (clamping or pressing is not necessary). After use, remove static mixer and place cap on the double syringe.

Potlife: 90 minutes

Stains/residue: Remove wet adhesive residue immediately with warm water and soap. Dry adhesive residue can only be removed mechanically.

CURE TIMES*

Drying/Curing time: approx. 90 minutes

Final bonding strength after: approx. 12 hours

Afschuifsterkte UHU Plus endfest 300 Résistance au cisaillement UHU Plus endfest 300		
Temperatuur Température	**Uithardingstijd Temps de séchage**	**Eindsterkte[1] Résistance finale[1]**
20°C	12 uur	± 1200 N/cm²
40°C	3 uur	± 1800 N/cm²
70°C	45 min	± 2000 N/cm²
100°C	10 min	± 2500 N/cm²
180°C	5 min	± 3000 N/cm²

[1]Afschuifsterkte aluminium-aluminium

[1]Résistance au cisaillement aluminium-aluminium

* Curing time may vary depending on a.o. surface, product quantity used, humidity level and ambient temperature.

45738 20181115

45738 - UHU PLUS ENDFEST 300 DOUBLE SYRINGE 50 ML DE - 45735

UHU PLUS ENDFEST 300

EXTREMELY STRONG, UNIVERSAL, SOLVENT-FREE, DUAL-COMPONENT EPOXY ADHESIVE

TECHNICAL PROPERTIES

Moisture resistance: Good
Water resistance: Good
Temperature resistance: -40°C - +100°C
UV resistance: Very good
Chemicals resistance: Very good
Paintability: Good
Filling capacity: Very good

TECHNICAL SPECIFICATIONS

Appearance: Binder: Opaque with high viscosity; Hardener: Honey Coloured with medium viscosity
Chemical base: Binder: Epoxy Resin; Hardener: Aliphatic Amines
Bonding technique: 1-sided application
Consistency: Liquid
Viscosity: approx. 35.000 mPa.s., Liquid
Solid matter: approx. 100 %

Alteco Adhesive Data sheet

ALTECO®

MATERIAL SAFETY DATA SHEET

2Ton Quick Epoxy/3Ton Quick Epoxy RESIN

Date: 11 September 2017
Rev No.: 0

1. IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY

Product Name:	2Ton Quick Epoxy/3Ton Quick Epoxy Resin
Company:	Alteco Chemical Pte Ltd 19 Tuas Avenue 11 Singapore 639084
Telephone:	+6568620377
Fax:	+6568620221

2. HAZARDS IDENTIFICATION

GHS Classification:	Acute toxicity	Class 5
	Skin irritation	Class 2
	Aquatic Chronic	Class 2
	Skin sensitizer	Class 1

GHS Label Element:
Pictogram

Signal Word:	Warning
Hazard Statement(s)	May be harmful if swallowed. Cause skin irritation. May cause an allergic skin reaction. Cause serious eye irritation. Toxic to aquatic life with long lasting effects.
Precautionary Statement(s)	Wear protective gloves. If swallowed, rinse mouth. If on skin, wash with soap and water. If in eye, rinse with water. Remove contact lenses. If exposed or concerned, get medical treatment. Dispose of contents and container, send to licensed operator.
Hazard symbol(s)	Irritant

3. COMPOSITION / INFORMATION OF INGREDIENTS

Component	CAS No.	Percentage
Bisphenol A Epoxy resin	25068-38-6	45-55%
Talc	14807-96-6	45-55%

4. FIRST-AID MEASURES

After Inhalation: If inhaled, remove to fresh air. If not breathing give

	artificial respiration. Consult a physician.
After Skin Contact:	In case of contact, immediately wash skin with soap and copious amounts of water Consult a physician.
After Eye Contact:	In case of contact, immediately flush eyes with copious amounts of water for at least 15 minutes and consult a physician.
After Ingestion:	Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIRE-FIGHTING MEASURES

Extinguisher Media:	Suitable: Carbon dioxide, dry chemical powder, or appropriate foam.
Special Protecting Equipment or Firefighter:	Wear self contained breathing apparatus and protective clothing to prevent contact with skin and eyes.

6. ACCIDENTAL RELEASE MEASURES

Procedure(s) of Personal Precaution(s):	Wear respirator, chemical safety goggles, rubber boots, and heavy rubber gloves.
Environmental Precautions:	Do not let product enter drain.
Methods for Cleaning up:	Sweep up, place in a bag and hold for waste disposal. Avoid raising dust. Ventilate area and wash spill site after material pickup is complete.

7. HANDLING AND STORAGE

Precautions Handling:	Avoid contact with skin and eyes. Avoid formation of dust and aerosols. Provide appropriate exhaust ventilation at places where dust is formed. Normal measure for preventive fire protection.
Condition for Safe Storage:	Store in cool place. Keep container tightly closed in a dry and well-ventilated place.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Control:	Safety shower and eye bath. Mechanical exhaust required.
General Hygiene Measures:	Wash thoroughly after handling.
Personal Protecting Equipment:	Respiratory Protection: Government approved respirator. Hand Protection: Compatible chemical resistant gloves.

GEDIS LUB
la qualité en plus

Eye Protection: Chemical safety goggles.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Black paste

Property:	Value:
pH:	N/A
BP/BP Range:	N/A
MP/MP Range:	N/A
Flash Point:	N/A
Flammability:	N/A
Autoignition Temp:	N/A
Oxidizing Properties:	N/A
Explosive Properties:	N/A
Explosion Limits:	N/A
Vapor Pressure:	N/A
Water Solubility:	N/A

10. STABILITY AND REACTIVITY

Stability and Reactivity:	Stable under normal storage condition.
Condition to avoid	Avoid contact with heat and ignition sources.
Materials to avoid	Strong oxidizing agent, acids, bases
Hazardous decomposition products:	Carbon dioxide. Carbon monoxide.

11. TOXICOLOGICAL INFORMATION

Acute toxicity:	May be harmful if swallowed.
Skin corrosion / irritation:	Cause skin irritation
Serious eye damage / eye irritation:	Cause eye irritation.
Respiratory or skin sensitization:	May cause sensitization by skin contact.
Germ cell mutagenicity:	No data available
Carcinogenic	No data available.
Reproductive toxicity:	No data available
Specific target organ toxicity – single exposure:	No data available
Specific target organ toxicity – repeated exposure:	No data available
Aspiration hazard:	No data available

Potential health effects

Inhalation	Maybe harmful if inhaled. Causes respiratory tract irritation.
Ingestion	Maybe harmful if swallowed.
Skin	Causes skin irritation.
Eyes	Causes eve irritation.

12. ECOLOGICAL INFORMATION

Toxicity	Moderately toxic to aquatic life.

13. DISPOSAL CONSIDERATIONS

Substance Disposal:	Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber. Observe all federal, state, and local environmental regulations.

14. TRANSPORT INFORMATION

RID/ADR:	No regulated.
IMDG:	No regulated.
IATA:	No regulated.

15. REGULATORY INFORMATION

Not applicable

16. OTHER INFORMATION

DISCLAIMER:	Information provided is based on our up to date knowledge.

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VITA

NAME Khanh Nguyen Quang

INSTITUTIONS ATTENDED

M.A (Cultural Management) Vietnamese, 2019
HCMC University of Culture, Vietnam.
Thesis Title "Conservation and Management of underwater archaeological Heritage: A case study in the shipwreck sites objects belonging to Kien Giang Sea", 2019.

B.A (Museum Study), Vietnamese, 2011
HCMC University of Culture, Vietnam
Thesis Title"Management Methodologies of Thailand's Ceramic Collections 14-15 centuries in the Kien Giang Museum", 2011 .

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2. "Human Resources of Conservation and Promotion of the Values of Cultural Heritage in Mekong Delta," paper presented at the HCMC Conference, November 2022.

3. "Conservation Staff in Vietnam Museums: Challenges and Cooperation," paper presented at the 5th International Conference of Silpakorn University International College (SUIC), Thailand, December 2019.

4. "Oc Eo Culture Heritage of Kien Giang – An Giang Provinces: Challenges of Cooperation and Development Opportunities," paper presented at the Conference of An Giang Province, November 11, 2019.

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