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Marika Susanne Brandt

Glass Artisan

SOMEWHERE BETWEEN THE WAVES IS THE BLANK SPACE

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Orientadores: Professora Doutora Inês Coutinho,
Professora Auxiliar da NOVA School of Science and
Technology

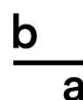
Professor Doutor Pedro Fortuna, Professor Auxiliar da
Faculdade de Belas Artes da Universidade de Lisboa

Presidente: Catarina Villamariz, Assistant Professor, FCT NOVA
Arguente(s): João Pedro Veiga, Associate Professor, FCT NOVA
Marta Castelo, Assistant Professor, FBAUL

Vogal(ais): Inês Coutinho, Assistant Professor, FCT NOVA



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For all those who wander into the blank space.

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Resumo

A pasta de porcelana comercial disponível no mercado português tem uma plasticidade excepcionalmente baixa, pelo que não é muito adequada para ser trabalhada à roda ou para ser conformada manualmente. Em estudos anteriores, comecei por desenvolver porcelana com maior plasticidade e criar esculturas usando a técnica de conformação à roda. Ao continuar este trabalho, um dos objectivos foi explorar outra característica importante da porcelana, que é a translucidez. Esta qualidade torna a porcelana única entre os outros materiais cerâmicos. A translucidez é uma parte importante da obra de arte, porque esta comunica por meio da materialidade, forma, cor e composição.

Tornar a porcelana mais plástica e translúcida exigia o uso de matérias-primas opostas, o que implicou o estudo de todas as matérias-primas existentes na porcelana e entender como a translucidez pode ser explorada. Neste trabalho foi estudada a formação do cristal de anortite, um dos componentes que torna a porcelana mais translúcida. O objetivo principal era encontrar uma combinação na composição da porcelana de forma a manter a plasticidade trabalhável enquanto se aumenta também a translucidez. A porcelana produzida durante este trabalho tem plasticidade suficiente para ser conformada à roda e modelada em esculturas. Também possui translucidez que dá suporte ao conceito artístico.

Palavras-chave: Porcelana, Conformação à roda, Translucidez, Plasticidade, Comunicação, Materialidade

Abstract

The commercial porcelain available on the Portuguese market has an exceptionally low plasticity and therefore it is not very suitable for wheel throwing or hand building. In my previous studies I was able to develop porcelain with higher plasticity and create sculptures using the wheel throwing technique. When continuing this work, I wished to work on another important quality for the porcelain, which is translucency. This quality makes porcelain unique among other ceramic materials. The translucency is an important part of the artwork as it communicates through the materiality, shape, colour, and composition.

Making porcelain plastic and translucent required quite opposite raw materials, which forced me to study every raw material and understand how the translucency can be explored. In this work the formation of anorthite crystal, which is one of the components that makes the porcelain more translucent, was studied. The main aim was to find a combination to keep the workable plasticity while increasing the translucency. The porcelain that was produced had enough plasticity to be thrown on the wheel and to be modelled into sculptures. It also has translucency that supports the artistic concept.

Keywords: Porcelain, wheel throwing, Translucency, Plasticity, Communication, Materiality

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Abbreviations and nomenclature

This is to clarify some of the terms I use in the text.

MBT - The compositions I produced for my thesis work, where the goal was to reach a good plasticity and translucency

Maturing point – Temperature where porcelain reaches zero porosity

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1. INTRODUCTION

The characteristics of porcelain has fascinated people for centuries. The white, strong, translucent material, that was discovered and invented in China at least 1000 years ago, has made its way from unique collectable to one of the most commonly used materials in our time. The Europeans have been fascinated by the Chinese porcelain since the traders started to transport it from China in the 16th century and had have tried to produce it since then. It was only in the 18th century that the chemist Johan Böttger who worked in Meissen ceramic factory in Germany, successfully developed a recipe to make porcelain. While the Europeans tried to produce the admired porcelain, they came up with two other types of porcelain: soft paste porcelain and bone china. Even Faience and the characteristic blue - white tiles, (which can be found everywhere in Portugal) tried to imitate the Chinese porcelain with their patterns.

My interest in ceramics started only four years ago when I was introduced to wheel throwing. I fell in love with this technique from the first try. Wheel throwing requires the same kind of coordination skills as glassblowing, which has been the foundation of my work with art and therefore the technique spoke to me immediately. With ceramics, I was able to touch the material with my fingers, and have this tactile connection to the material, without burning myself. After this experience I started to deepen my knowledge in ceramics and included the material into my art. After some years of throwing ceramics, I wanted to try to throw porcelain on the wheel. I was told by my professor that the porcelain we had in Portugal was not very suitable for wheel throwing, because of the poor plasticity. This stayed in my mind and when the moment came that it was time for me to choose a subject for science project, I chose to work with porcelain, trying to increase the plasticity of the porcelain, and make it more suitable for wheel throwing. Learning to create a recipe, mix the batches, and understand the role of different raw materials has kept me both interested and curious for the path that I am still following.

There was a proud Teapot, proud of being made of porcelain, proud of its long spout and its broad handle. It had something in front of it and behind it; the spout was in front, and the handle behind, and that was what it talked about. But it didn't mention its lid, for it was cracked and it was riveted and full of defects, and we don't talk about our defects - other people do that. The cups, the cream pitcher, the sugar bowl - in fact, the whole tea service - thought much more about the defects in the lid and talked more about it than about the sound handle and the distinguished spout. The Teapot knew this.¹ (Andersen, 1863.)

In my thesis I have chosen to further develop the porcelain, that I started in my science project and use both glass and porcelain together in a sculpture. For the artistic purposes of my project, the porcelain needed to have a good workability. By this I mean a good plasticity that would allow it to be thrown on the wheel. I also wanted to increase the translucency which is so characteristic for porcelain and a unique quality within this material in ceramics. I use the transparency and translucency of the material to increase the illusion of fragility in my artwork.

¹ H.C. Andersen, 1863, Teapot

In my artistic body of work, I have tried to give a voice to each one of them. I allow the sculptures and installations to tell their story through the slightly animated style and the materiality. They speak through their form, colour, structure, and shape. Each object has a dialogue with each other and a silent interaction between them; the non-verbal connection, expressing the feelings and memories from the past, from birth to possible rebirth, through the constant change. Glass and porcelain both have this clean perfection in them, the smooth surface and fragility. In my sculptures I have used this perfect surface in contradiction to something imperfect. The imperfection in perfection, or the perfection in the imperfection.

About a year ago I started therapy and finally understood that I have been struggling with anxiety my whole life, one of my own imperfections. It had been part of me for so long, that I had become a master of hiding it. Anxiety had caused me several depressions and put me into very unpleasant situations, without me even knowing what was causing this. I felt ashamed of the fact that my anxiety was not discovered sooner and that I thought this was how everyone else was feeling as well. After I was able to acknowledge my anxiety, I understood new things about me. Not just my behavior, but how it affected my work as an artist.

"I know them," it told itself. "And I also know my imperfections, and I realize that in that very knowledge is my humility and my modesty. We all have many defects, but then we also have virtues. The cups have a handle, the sugar bowl has a lid, but of course I have both, and one thing more, one thing they can never have; I have a spout, and that makes me the queen of the tea table. The sugar bowl and the cream pitcher are permitted to be serving maids of delicacies, but I am the one who gives forth, the adviser. I spread blessings abroad among thirsty mankind. Inside of me the Chinese leaves give flavor to boiling, tasteless water." (Andersen, 1863)¹

My earliest memories of anxiety are when I was about seven years old. I would often lie in my bed and plan how to escape if there was a fire in the building. I would create these worst-case scenarios in my head to be able to be prepared for the worst, always. Later, I would make myself rules, a lot of rules, that would make me feel safe, or at least I thought so. I would have rules, so I would have control of the situations in my life. Lately I understood that it was the need of feeling safe that made me write those endless to-do lists, look for my keys 25 times during a 20-minute bus ride, and checking the lights and gas at least 10 times before leaving home. Each act was a tiny moment of relief that made me feel safe. Repetitions were intended to create the balance and the safety.

This was the way the Teapot talked in its fresh young life. It stood on the table that was prepared for tea and it was lifted up by the most delicate hand. But that most delicate hand was very awkward. The Teapot was dropped; the spout broke off, and the handle broke off; the lid is not worth talking about; enough has been said about that. The Teapot lay in a faint on the floor, while the boiling water ran out of it. It was a great shock it got, but the worst thing of all was that the others laughed at it - and not at the awkward hand. (Andersen, 1863)¹

From the outside it can be difficult to see these “invisible defects” or “imperfections” because we usually see only what we are shown, the surface, the picture that is painted or the mask that is put on. By getting to know each other, we become more translucent, even transparent, and we are capable of understanding each other’s non-verbal communication. Interpreting art in any form is a non-verbal communication, and just like any form of communication the final message depends on the receiver and how the message is received.

Thesis title “Somewhere between the waves is the blank space” refers to the waves of light and the waves in life. The current ups and downs, through the spectrum of feelings from grief to happiness. The blank space refers to an area that allows the viewer, to create the interpretation of the art piece. The pieces that communicate through their form, structure, composition, and materiality, leaving space for individual imagination to create their own story and aspire to broader meanings.

1.1 STATE OF ART

Portugal is known for its ceramics and porcelain, but unfortunately the commercial porcelain that is on the market in Portugal is not very suitable for the potter’s wheel, because of its low plasticity. Prior to my thesis work, I had already worked with porcelain where I increased the plasticity within the material. This made the porcelain more suitable for wheel throwing and allowed me to make my work with the use of this technique. The high plasticity is also important in sculpting and hand building, and it allows one to bend and form the material without cracking.

In my thesis, I have continued to develop porcelain as a material and wanted to increase the translucency and keep the relatively high plasticity. With the relatively high plasticity I mean that it needed to be plastic enough to be suitable for wheel throwing. To succeed in that, I had to understand how the raw materials in porcelain work and what role each raw material has in the porcelain composition. In my research I have tried to find answers to the following questions: What is it that makes porcelain translucent? What is the best plasticizer? Do the plasticizers affect the translucency or the color of the porcelain? How to keep that good workability and plasticity? The challenge was to keep the good workability as I wanted to increase the translucency. As these two characteristics require the opposite raw materials, they ended up “fighting” a little against each other.

The translucency is an important quality for my artistic work, whereas the plasticity is a quality within the porcelain, allowing me to shape it. It is interesting how the science behind the material supports the art, and in my opinion the translucency increases the sense of fragility, which I have tried to use as part of my work. The use of material properties becomes an important part of my work. Both Michael White in his paper about materiality² and Amanda Du Preez – (im)materiality-on the matter of art³, write about the use of material properties in the artistic work. They write about the importance of the choice of a material, color, and texture, and how these can give form to silence, emptiness, and space. How the chosen material affects the impression that is received by the viewer. Therefore, the material becomes a part of the visual communication.

² Michael White, ‘Materiality’, In Focus: *Burn Hole* 1961 by Henk Peeters, Tate Research, 2019

³ Amanda Du Preez – (im)materiality-on the matter of art, published 2008, a journal for design

Communication is an important part of our lives, and we cannot go through a day without it. Foluke Fatimayin explains in her paper “What is communication”⁴ the different forms of communication and how we communicate. Nida Ljaz’s paper “Art of Visual Communication, Evolution and its Impact”⁵ is more focused on the power of visual communication, especially in marketing, but which can also be transferred to fine arts. Both papers explain how communication is everywhere: humans, animals, plants and even micro-organisms have a way of communicating, the verbal and non-verbal communication, the human and non-human communication. We communicate through our senses, signs, signals, visual content⁵. Communication can be described with the following formula: 1. message 2. forming the message 3. sending the message 4. receiving the message 5. interpreting the message 6. feedback or response.⁴ The communication can be intra-personal too, where we talk to ourselves. This led me to wonder if making art is always an intra-personal conversation or if the artist is talking to someone else? Can the communication also be transparent, translucent, or opaque?

The word translucency means that the light can pass partly through the material and make it slightly visible for us to see to the other side. It is not transparent, where you can clearly see through, and its neither opaque, which does not let any light pass.

Often the words transparency, translucency and opacity are used to describe the material ability, but it can also refer, in a metaphorical sense, to a human behaviour, communication and the way literature is understood. In the paper “the poem as a craft” Willow Hambrick describes the states of understanding the poetry. She uses the transparent, translucent, and opaque scale as a measurement on how easily the poem is interpreted.⁶ I find that interesting as it applies similarly to communication and interpreting art in general.

Making translucent porcelain one must pay attention to the thickness of the piece. The grade of translucency is directly related to thickness of the piece and the source of light. The importance of the thickness is discussed on the papers “Lithophanes not a dead artform”⁷ and “Lithophanes: Magic Illuminated”⁷ by Margaret Carney. This artform called lithophanes was created in Europe in 1820s, but Lithophane tutorial⁸ states that it was discovered in China before that. Lithophanes are 3D plaques made from a translucent material, for example porcelain. Lithophanes reveal the picture when the light source is placed behind the object, and the play between the thin and thick areas, will create the image. For me it seems that the lithophanes are the predecessor of translucent porcelain in modern art. The interaction between light and the material is always there, whether it is the surface texture of the state of translucency, they all need light for the interaction. Seems like the interaction with the material and light has been the inspiration for many artists, but especially those who work with porcelain, such as Rudolf Staffel, Jeroen Bechtold and Edmund de Waal.

While trying to achieve translucent porcelain, I cannot help thinking that this is a step closer to producing glass or glazes. We are playing with the same ingredients, and I can feel myself drawing parallels between these two / three materials. It was especially important for me to understand what is happening in the body of the porcelain, and how it can become translucent. It is more glasslike than other ceramic materials and the ability to become translucent is something that moves it closer to glass. The main difference is that glass does not crystallize due to its amorphous liquid structure, while porcelain and ceramics have a crystalline structure. The paper by A. B. Jermolovicius, and A. L. Molisani⁹ explains how the translucency in porcelain is received by the formation of crystals in the porcelain body. The grains of crystals are divided, and they let the light pass through. The crystals that are forming in porcelain body can be detected by XRD analysis, which I also used to characterize my samples.

⁴ Fatimayin, Foluke. (2018). What is Communication?

⁵ Ijaz, Nida. (2018). Art of Visual Communication, Evolution and its Impact. Indian Journal of Public Health Research & Development.

⁶ Hambrick, 2018, The Poem as Craft: Poetic Elements

⁷ Carney, 2012, Lithophanes not a dead artform, Ceramics: Art and Perception No. 87

⁸ Lithophane tutorial, April 2020 http://www.denfordata.com/pdfs/lithophane_tutorial.pdf

⁹ Jermolovicius and Molisana, 2018, Translucent colored porcelain for decorative lighting fixtures

The article by Tony Hansen¹⁰ gave several examples on how to increase the translucency in porcelain and what to pay attention to, also in terms of keeping the needed plasticity. The translucent porcelain body must be highly vitreous (have a high silica content), and the amount of flux is important. Flux is the ingredient that lowers the fusion temperature with silica, and the fusion with silica is needed in order to create the translucency. The flux can be a source that is rich in potassium, sodium, or calcium. Lead can also be used as a flux in glazes and glass making (lead crystals), but it is very toxic and therefore no longer used in glassmaking or tableware production. The flux that is typically used in porcelain body is either potassium or sodium feldspar. It can also be CaO₂ based source like for example bone ash or Dolomite. Bone ash is used to make bone china and it's traditionally made from grinded animal bones. By increasing the amount of flux in a porcelain body, it also increases the translucency. The kaolin should be low in TiO₂ and in iron because titanium oxide is an opacifier and a colorant and therefore high TiO₂ content makes the porcelain body less translucent. If the kaolin has a high iron content, it will affect the whiteness and make the porcelain more yellowish. According to Hansen's article it is not necessarily true that the porcelain body should be fired well past the temperature, where it reaches zero porosity, but the author does not explain why.

The research paper by Yahya, Ahmad, and Ibrahim¹¹ bring up an interesting fact on how the religious beliefs can influence the tableware production. Bone china is not preferred in Muslim countries due to non-halal bones that are used to make bone china. In Bone china the flux is traditionally made from ground animal bones, as a source for calcium. In this study they try to achieve the translucency by using other CaO based materials, such as dolomite, limestone, wollastonite, and calcite. They investigated the dolomites effect on the translucency when different percentages were added to the compositions. This study shows that formation of anorthite crystals (CaO·Al₂O₃·2SiO₂)¹² increases the translucency in porcelain due to refractive index value, which is closer to the glass phase. The study showed that too much dolomite (more than 23%) decreased the formation of anorthite which made porcelain less translucent. It also shows how CaO based flux can be used instead of feldspar and how the amount of flux plays an important role in porcelain making.

When we think about the history of porcelain and how it seems that this "white queen" has fascinated people around the globe for centuries; in this context I find the paper by paper By T. S. Lekareva, L. M. Dmitrieva, and N. I. Kholodok¹³ remarkably interesting. It explains how The Gusev stone was found in the Primorsk region in Russia and used for porcelain making. It contains all the basic components of porcelain body: kaolin, quartz, and feldspar. I find it important and interesting that they were able to use a locally found material, especially when we think of the importance of porcelain production and how this invention has changed our lives globally.

¹⁰ Hansen, Translucency, year unknown, [Translucency \(digitalfire.com\)](http://digitalfire.com)

¹¹ Yahya, Ahmad and Ibrahim, 2019, Effect of dolomite on translucency and mechanical properties of whiteware, AIP Conference Proceedings

¹² Pal, Das and Das, 2014, Anorthite porcelain: synthesis, phase and microstructural evolution

¹³ Lekareva, Dmitrieva and Kholodok, 1966, Very white and translucent porcelain based on Gusev stone, State Research and Project Institute for the Ceramic Institute (GIKI)

1.2 ORIGINS OF THE PORCELAIN

We use porcelain in our everyday life, and quite often we are not even aware of it. It is the queen of the ceramic materials and desired because of its qualities: toughness, strength, and translucency and due to its beautiful surface and non-porous structure.

Porcelain is used everywhere; from toilets and sinks to tableware and to the dentist office. Therefore, it is quite hard, if not impossible, to go through a day without engaging contact with an object made from porcelain. This desired material was introduced to Europe by traders, and it caused a lot of suffering to people who were held prisoners as they tried to find the secret of producing it. Different sources tell a different story, but it is likely to have been the Portuguese or the Dutch, who brought porcelain to Europe from China. Until around early 18th century, we did not know how to produce porcelain in Europe, which is probably why it became such a desirable material. Now porcelain has made its way to every household and the recipes are no longer a secret.

Porcelain slowly evolved in China about 1400 to 1000 years ago depending on the source.^{14 15 16} The town called Jingdezhen, which is in Jiangxi, in the south-east part of China, is said to be the birthplace of porcelain. Kaolin, which is the main ingredient of porcelain is named after the mountain village Gaoling, which is where the kaolin was first mined. These mountains offered a natural source for porcelain making and it became desired due to its unique qualities. Kaolin was mixed with Petuntse or China stone, which are felspathic rocks. This kaolin was also slightly different compared to the kaolin that has been mined on other places on earth. The Chinese kaolin was more plastic and the Chinese potters did not need any other clays in the porcelain composition to increase the plasticity.¹⁴ Therefore they were able to produce this beautiful white porcelain without impurities from other clays. Porcelain slowly spread to other East Asian countries, and finally Europe and the rest of the world. The word "porcelain" is traced to the term "porcella," the Italian name for cowrie shells. Porcelain had the same shiny veneer and whiteness as these natural objects.¹⁵

The Japanese also loved porcelain and it was imported there from early on. The Japanese did not know how to produce porcelain, until the Korean potters arrived during the Japanese invasions in Korea in 1592-1598. The potters were taken as captive and to develop porcelain. The Korean potters brought a different type of kiln with them and one of the potters found a source for porcelain clay near Arita.¹⁷

The first porcelain and kaolin were imported to Europe by Portuguese traders (again depending on the source) on the 16th century, but it was only on the early 18th century that Johann Böttger of Meissen, Germany, discovered the way to make porcelain. He worked as an alchemist for King Augustus of Poland, although some sources also suggest he was held as a prisoner and forced to create the porcelain.¹⁸ King Augustus loved Chinese pottery and wanted to buy fine teapots among other fine things. After Böttgers breakthrough in early 18th century, the Meissen factory started to produce the hard-paste porcelain, which required extremely high temperature to become translucent.

¹⁴ Rodhes, 1957, Clay and glazes for potter, p.62, p.82, p. 80-82, p.36, p.36, p. 54, p. 80-81, p. 54-55, p.65-68, p.74, p.98, p.74-75

¹⁵ De waal, 2015, The white road, p.27, p.32

¹⁶ D'Souza, 2020, The history of porcelain from ancient China to Europe, The sprucecrafts

¹⁷ Woffinden, 2014, The Village of the Secret Kilns, Okawachiyama, JoWoffinden.wordpress

¹⁸ Gal, 2017, Qualia as Value and Knowledge: Histories of European Porcelain, <https://doi.org/10.1086/690108>

While the Europeans were trying to come up with the secret for porcelain making, the soft-paste porcelain and bone china were created. Soft-paste porcelain was made from clay and ground glass and fired at 1200°C. This material was not a true porcelain, being much softer and rougher. The first major Western development was the discovery of bone china. It was developed by the British potter Josiah Spode in about 1800. Spode added calcined bone ash to hard paste mixes to produce a hybrid porcelain. The bone ash is usually made from grinded swine bones and is used as a source for calcium. Calcium works as a flux in the porcelain composition and can produce very translucent porcelain. Bone china is still widely used in the UK.¹⁹

1.4. WHAT IS PORCELAIN - PORCELAIN RAW MATERIALS AND THEIR ROLE IN THE COMPOSITION

Porcelain is a clay material that does not have pores. When fired, porcelain becomes extremely hard, resistant, and translucent (depending on the thickness) and it does not absorb water. These qualities arise mainly from vitrification and the formation of the mineral mullite within the body at these high temperatures. Porcelain can be divided into three categories: soft-paste, hard paste, and bone china. In my studies I have focused on making hard paste porcelain, which I am now calling porcelain in this thesis.

The most important ingredients in porcelain body are roughly 50% plastic clays: China clay - kaolin, (ball clay or bentonite can be added as a plasticizers) 25% quartz and 25% fusers (feldspar, CaCO₃). Clays used for porcelain are generally of lower plasticity and the working range is shorter than many other pottery clays. They wet very quickly, meaning that small changes in the amount of water can significantly change the workability. Therefore, the range of water content within which these clays can be worked, is very narrow and consequently must be carefully controlled.¹⁴ For example, I feel that when porcelain is leather dry and ready to be trimmed to its final shape, the time window for this process is short. Also, if cracks appear on the body at this state, they are extremely difficult to fix and will most likely show up again when fired.

The plasticity refers to how flexible a clay or a clay body is. Clay body is greatly influenced by the clay's particle size, water content and aging (mold growing). Plasticity is also known as the quality or state of being plastic, a capacity of being molded or altered. Wheel throwing requires a high plasticity, for the piece to be shaped. The plasticity can for instance be measured by making a coil and wrapping it around your finger. Clay with good plasticity can be bend this way without cracking. Aging and mold growing can increase the plasticity, but this consumes much time. Small organism that can grow within clay, increase the binding action or attraction of the clay platelets.¹⁴

Kaolin is the main clay ingredient in porcelain, it comes from the mineral kaolinite, and it fires very white. It has a low plasticity and low shrinking percentage to drying and firing stages. Because of kaolin's poor plasticity it is difficult to use it without any other clays in the paste. Kaolin is also called China clay, because of its use in porcelain. Kaolin is a refractory clay and has a high melting point (around 1800 C⁰). Therefore, other clays are added to increase the workability and lower the maturing temperature together with the flux. In porcelain the maturing temperature is when it reaches the zero porosity.

¹⁹ Britannica, T. Editors of Encyclopaedia (2020, January 10). *Porcelain*. *Encyclopedia Britannica*. <https://www.britannica.com/art/porcelain>

Kaolinite is a soft, earthy, usually white, mineral produced by the chemical weathering of aluminum silicate minerals like feldspar. In many parts of the world it is coloured in pink, orange or red tones by iron oxide and to give it a distinct rust hue, kaolinite clay occurs in soils that have formed from the chemical weathering of rocks in hot, moist climates, such as in tropical rainforest areas. Kaolinite is one of the most common minerals on earth and it is mined worldwide for example in UK, USA, Brazil, Spain, South Africa, Australia, and in Vietnam.¹⁴

In the USA, the main kaolin deposits are found in central Georgia, on a stretch of the Atlantic Seaboard fall line between Augusta and Macon. This area of thirteen counties is called the "white gold" belt; Sandersville is known as the "Kaolin Capital of the World" due to its abundance of kaolin.^{20 21}

Besides the use in porcelain and as a refractory element, kaolin is used in various other products. It is used for paper, rubber, paint, toothpaste, in medicine for diarrhea and in organic farming, to name a few. Kaolin is also used as an extender and flattening agent in paints and it is an important ingredient in ink, organic plastics, some cosmetics, and other products where its fine particle size, whiteness, chemical inertness, and absorption properties give it a value.¹⁴

Kaolin's structure changes when heated. Between 100 °C and about 550 °C all the chemical water is removed from kaolin. Until this point (around 550 °C) kaolinite can still be dissolved in the water, but after this the chemical changes in the structure will make the kaolinite into a ceramic (porcelain) body and it cannot be turned into its clay form again.

Silica, commonly known in the form of quartz, is the dioxide form of silicon, SiO₂. Quartz is the second most common mineral on Earth's crust, right after feldspar. It is an essential element of clay, and it is also used to manufacture glass. Quartz is commonly used in porcelain (and stoneware) where its role is to improve the resistance of the body and keep it from warping, and to give stability and hardness to the final body. Quartz is also used in glazes as a glass former. Many raw materials contain silica such as kaolin and ball clay.¹⁴ Pure silicate like quartz could be used for glassmaking, but it has a high melting temperature (1723 °C) and high viscosity, which makes it difficult to work with. Therefore, other raw materials are added in glassmaking to improve the workability and by lowering the melting temperature and the viscosity.

Quartz exists in two forms, the normal α -quartz and the high-temperature β -quartz. The transformation from α -quartz to β -quartz takes place abruptly at 573 °C¹⁴. The transformation changes the volume, and therefore this is a critical step of the firing process. This transformation is one of the behaviors seen by means of dilatometry analysis.

Feldspar is the most common mineral on earth and covers about 41% of it. Feldspar is mostly produced in Italy, Turkey, and China. Feldspar is a common raw material used in glassmaking and in ceramics. In glassmaking, alumina from feldspar improves product hardness and durability. In ceramics, the alkalis in feldspar (calcium oxide, potassium oxide, and sodium oxide) act as a flux, lowering the melting temperature of a ceramic body or glaze. Fluxes melt at an early stage in the firing process, forming a glassy matrix that bonds the other components of the system together. Feldspars are one of the most important materials for medium and high temperature glazes, and in ceramic and porcelain body. Potash feldspars are often not as pure or white as soda feldspars, which is caused by the fact that potash feldspar come from orthoclase mineral which gives it a slightly pinkish color. Besides the color, potassium feldspar has a higher melting temperature (around 1200 °C) than soda feldspar.²²

Ball clays are quite opposite to Kaolin. They have fine particle size, low iron content (high compared to kaolin) and they are much more plastic. The term 'ball' traces to historic mining in England where large chunks of the clay were cut from the bank in ball shapes for transport to processing.¹⁴ Ball clay is mined mostly in eastern USA and in southwest UK^{14 23}. Because of the plasticity of ball clay and the high shrinkage,

²⁰ Schroeder, Paul A. "Kaolin." New Georgia Encyclopedia. 31 July 2018. Web. 14 June 2021

²¹ KaolinCapitaloftheWorld.cfm - City of Sandersville (sandersvillega.org)

²² Hansen, Digitalfire, [Potash Feldspar \(digitalfire.com\)](http://PotashFeldspar.digitalfire.com)

²³ [What is Ball Clay](http://WhatIsBallClay) | The Kaolin and Ball Clay Association (kabca.org)

it is not suitable to be used alone in a ceramic paste. Ball clay and kaolin complement each other very well and they are therefore often used together in clay bodies, such as porcelains, stoneware, and earthenware. Its role in a ceramic body is to produce white color and increase the plasticity. Recipes with 20% or more ball clay risk shrinking and cracking during drying.

Bentonite usually forms from weathering of volcanic ash.¹⁴ One of the largest findings of bentonite is in Wyoming, USA²⁴. Bentonite is the most plastic and very absorbent clay material used in ceramics. It is an exceptionally good plasticizer in a ceramic body and makes the clay suitable for hand building and for potter's wheel. Bentonite has a high iron content and therefore its color might affect the color of the ceramic body. Because of the high plasticity, bentonite also has a high shrinkage, which may cause cracking during drying¹⁴. Bentonite also swells up when it's wet. It is due to these qualities that it cannot be used alone in a ceramic paste. The high plasticity of bentonite affects the drying process as it takes longer for the water to escape safely from the clay bodies. In pottery and porcelain clay bodies, adding only 2% bentonite can produce marked improvements in workability and dry strength without much effect on fired color. The use of up to 5% is common, especially where high plasticity is needed.

Bentonite is very absorbent, and it can be difficult to mix it properly, when making ceramic or porcelain paste. Because of the high absorbance, bentonite can be used in cat litter as well as medicine, such as bulk laxative and as a base for dermatologic formulas.¹⁴

2.2. WHITE DIRT- white, white and its many faces

Every light is a shade, compared to the higher lights, till you come to the sun; and every shade is a light, compared to the deeper shades, till you come to the night. John Ruskin (1879).

When talking about porcelain we cannot avoid talking also about the color white. The white gold, the white queen, you name it! What is it about the porcelain, and the color white? Why have people been so obsessed about this material and the whiteness of it for centuries, and why has it even caused people to be held captive for the development of this white gold? The Japanese kept the Koreans working for them and in Europe Johan Böttger was forced to develop porcelain by King Augustinus.

The white color is often seen as a symbol of purity, perfection, the good, honesty, the beginning, the neutral, and the new. White is an important color for many religions and in some Asian cultures²⁵ it is the colour for mourning. The white wedding dress symbolizes the purity and virginity. White is also associated with something that is clean or empty, such as the white space or the white paper and in modern architecture is a symbol of simplicity and modernity. If we think of the colour white in a scientific way, the white-coloured object do not absorb any wavelengths of light but reflects them all. Therefore, we see the white color.

²⁴ [Learn About Bentonite Mining in Wyoming \(wyomingmining.org\)](http://www.wyomingmining.org)

²⁵ [Colours of Mourning in Different Cultures of the World - Funeral Guide Australia](#)

The color white and the use of it can have different associations, and some are rather negative from my point of view. The white can be associated to racism and nationalism, which is why I decided to call "the white space" as the blank space instead.

During the Finnish civil war (January 1918 – May 1918), the popularity was divided to the whites and the reds. Whites were nationalist who claimed that the senate should be run by the aristocracy and the reds were the socialists who fought for the Finnish democracy²⁶. In America, The Ku Klux Klan is a racist organization and against immigrants. They rose in the southern USA after the civil war and attacked and murdered black Americans, while wearing white ropes and hoods. The white privilege is a huge problem that roots from the systematic racism that the "white man" has created.

White is also a color which can be associated with peace and more passive resistance, for instance the group called the White Rose, which was a non-violent group resisting the Nazi Germany. Hans Scholl, who was the one of the founders of this group, had several explanations for the origin of the name, but one of them was that the symbol of the white rose was intended to represent the purity and innocence in the face of evil.

In 2016 I travelled to Singapore and came across a product to bleach your skin. It was completely new to me and kind of a shock too, that the beauty standards "require" people to harm themselves this way. It was back then when I learned that the skin bleaching is popular in Africa and Asia because it is desired to have a lighter skin tone. In India half of the skin products are meant to lighten your skin. Centuries ago, during renaissance and baroque the white skin was also desired In Europe and in the western world. It was a status symbol that defined the difference between the aristocracy and the "working people", who were outside exposed to the sun. In my view the beauty standards and the obsession of the white skin seems very odd. The skin is a marvelous creation which protects our body. The skin tones are the result of the evolution, which designed the whiter skin to obtain vitamin D easier and the darker skin to be more protective and for people living in the areas with little sun have lighter skin tone and vice versa. I was born in Finland, and we do not have a lot of sun there. Therefore, people with darker skin must take vitamin-D supplements.²⁷

Translucency is one of the qualities that make porcelain unique, together with the whiteness, smoothness, and toughness. These qualities have inspired a lot of artists to play along with the light and the sense of fragility. It also feels that everyone who is interested in porcelain, are fascinated by not only about the qualities, but the history as well. Porcelains journey from China to the one of the most common used materials in our time.

26 Tepora, 2014 Finnish Civil War 1918 DOI: [10.15463/ie1418.10084](https://doi.org/10.15463/ie1418.10084).

27 Juzeniene, 2011, why skin colours differ

ARTISTS WORKING WITH PORCELAIN



Fig.1 Manhattan series 2005, Jeroen Bechtold
©Bechtold, Jeroen | Capriolus Contemporary
Ceramics - Keramiek Galerie



Fig.2 Light gatherer, Rudolf Staffel © Rudolf Staffel



Works from Edmund De Waal **Fig.3** (left) Kaolin painting, Cold mountain I, 2020 **Fig.4** (middle) Some winter pots, 2020 **Fig.5** (right) Installation Breathturn I, 476 vessels, 2013 ©Making - Edmund de Waal

When talking about the material or materiality, my thoughts go quite soon into consumption and accumulation, the way we live, where nothing is ever enough. In technology there is always a new model every year. In design, new models, and colors attempt us to consume more. All this translates into the overuse of our planet's resources. Destroying forests to be able to build more, consuming more we can produce. The way we produce is directly toxic for the environment. Having things, owning things, hoarding things. Our modern lifestyle is solely responsible for what we are experiencing now; natural disasters caused by the climate change, pandemic.

Materiality has also another meaning and the "brighter" side, which I try to remind myself of when the "material world" is about to suffocate me. As a material, glass and ceramics have deep roots in arts and crafts and architecture. The material itself and the ingredients come from the Earth. A renewable resource that has no significant value in itself (compared to gold, for example), but instead the value is gained through the process of making. Ingredients that are carefully cleaned and prepared by the artist or craftsman. Used in arts and crafts or as a building material, satisfying the basic needs in order for people to live their lives and survive.

As an artist I feel that making my own porcelain recipes, mixing the ingredients, drying it, wedging it, helps me feel closer to the roots of the material. The feeling of that this is mine, from the very beginning. It probably contains my DNA in form of a hair, blood, or skin. The produced porcelain treasures and contains the cultural heritage as it is based on the knowledge that was invented centuries ago and processing the material with the wheel throwing technique that was invented even before the common era. While cherishing the past and respecting the previous inventions, it all makes me feel closer to the material, whether it's going to be a cup that help to relief someone's thirst or a bowl that can keep your soup or porridge. It might also turn into a sculpture, referring to a distant memory that the mind asks the fingers to process.

Porcelain as a material has a direct connection to consumption and accumulation. Many products, from tableware to collectable decorative items are made from it. Therefore, when we mention porcelain the first thought for the most people are one of those items. This leads me also to question the value of porcelain and the real need of things. Where is the balance for what we need and what we want? For example, if you take people of my age, most of us born in the early 80's in Finland, our parents and grandparents have collected us a complete porcelain dining set for 12 people. Which makes me wonder Is this really necessary anymore? How of often do we have 12 people for dinner, and would you anyway want to use your finest tableware? For me, the works from the artist Michael Geertsen (fig.6- 7) and Wendy Walgate (fig.8-9), play along with the consumption and accumulation. Questioning the need to collect things, fill the space with things.

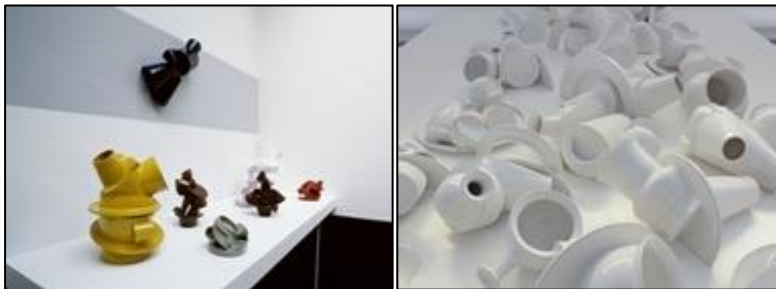


Fig. 6 (upper left) Assambles, Michael Geertsen, 2004 ©Exhibitions and Installations by Ceramic Artist Michael Geertsen

Fig. 7 (upper right) White noise-Potfield, Michael Geertsen ©Exhibitions and Installations by Ceramic Artist Michael Geertsen

Fig. 8 (below left) Horizon Mantle II, Wendy Walgate
©<https://walgate.com/>

Fig. 9 (below right) An Unlesioned Girl, Wendy Walgate
©<https://walgate.com/>

In my research of kaolin, I came across a documentary called “Eat white dirt”²⁸. In Georgia, USA, one of the main places where Kaolin is mined, people call kaolin as the white dirt. It is sold in some grocery stores and 80% of People eating kaolin, are women. According to this documentary this phenomenon of eating kaolin was documented worldwide, and they described that it was mostly among pregnant women, who had had anemia, that experienced craving for the white dirt. In medicine kaolin is used for treating diarrhea and in wound healing. It may also be good for your skin because it softens a dry skin. For me I think it was the name that brought up the irony and caught my attention. Since we call porcelain the white queen and the white gold, but actually the main ingredient is just white dirt.

2. COMMUNICATION THROUGH TRANSLUCENCY AND MATERIALITY

“Communication is constant with all the species. you cannot not communicate”²⁹ Watzlawick

Communication is everywhere. We all communicate. People, animals, plants, and even bacteria. Communication is sharing information by reading and understanding signals and symbols. It can be verbal on non-verbal, non-human, visual or written. Communication can happen between two or more participants, or it can also be an intra-personal communication within yourself. It is an interaction which usually starts when there is a motivation or reason for that. The message can be affected several ways on its way to the receiver, and for example disturbance from the outside, such as noise or body language that can change the intended message. This can be very frustrating, and misunderstandings will often rise. In our time the communication can be even more overwhelming than for example 15 years ago. The way we live at is extremely fast paste life and we are almost expected to be present and available all the time, to immediately answer emails, or messages. To be present on social media and share lot of information with people we do not even know.

The verbal communication refers to spoken words and sounds, and it is probably the most common way of communicating for humans. The verbal communication also contains nonverbal elements, and it is included in all the verbal communication. The rhythm of the speech, tempo, and volume, all have effect on the communication. The non-verbal communication affects us the most at the subconscious level and can establish trust or make us feel stressed.

Nonverbal communication is always present, and it also forms a universal communication system such as smiling, crying, or pointing. With nonverbal communication we mean all the nonverbal channels such as body, face, voice, appearance, touch, or distance. Nonverbal communication can be intentional, such as a handshake or unintentional like sweating or shaking. Written texts include nonverbal elements as well, such as handwriting style, lining of the sentences, the words we use or emojis. Nonverbal communication is very much relied on how well we express ourselves, or how well we interpret each other. There can easily be misunderstanding, especially if the nonverbal cues are different from the verbal language. When there is a contradiction between the words and behavior, the received message depends a lot on the receiver's mood, feelings, and each other's attitude, rather than the truth behind the words. I find non-verbal communication more transparent or translucent than the verbal communication. The words not said lay in the silence behind the words, in the blank space.

²⁸ Forrester, 2015, documentary, Eat white dirt

²⁹ Paul Watzlawick's law, [You Cannot Not Communicate - Paul Watzlawick - SciHi BlogSciHi Blog](#)

"I'll never be able to forget that!" said the Teapot, when later on it talked to itself about its past life. "They called me an invalid, and stood me in a corner, and the next day gave me to a woman who was begging for food. I fell into poverty, and was speechless both outside and inside, but as I stood there my better life began. One is one thing and then becomes quite another. They put earth in me, and for a Teapot that's the same as being buried, but in that earth, they planted a flower bulb. Who put it there and gave it to me, I don't know; but it was planted there, a substitution for the Chinese leaves and the boiling water, the broken handle and spout. And the bulb lay in the earth, inside of me, and it became my heart, my living heart, a thing I never had before. There was life in me; there were power and might; my pulse beat. The bulb put out sprouts; thoughts and feeling sprang up and burst forth into flower. I saw it, I bore it, and I forgot myself in its beauty. It is a blessing to forget oneself in others!"¹ (Andersen, 1863)

Visual communication includes photography, signs, and design and it is a powerful tool, especially in marketing. The picture combined with the text is a highly effective way of communication. Maybe the most common way of communication is the intra-personal communication. A dialogue with yourself, intentionally or unconsciously. We all do that. For example, by speaking out loud to ourselves, making a list or by writing a journal.

*"One day I heard them say it deserved a better pot. They broke me in two - that really hurt - and the flower was put into a better pot; then they threw me out into the yard, where I lie as an old potsherd. But I have my memory; that I can never lose!"*¹(Andersen, 1863)

The definition of Translucency is when a material can let light pass through, but it is diffuse and what is behind the object or material is not clearly visible. Transparent material lets the light pass through, and we can see what is on the other side, unlike an opaque material that does not let any light pass through it. On this scale translucency is somewhere between transparent and opaque, letting you only see partly through it.

Transparency, translucency, and opaque are terms that usually describe and define objects and their materiality. They can also be used to describe behavior, communication or to define literature and poetry. For example, the transparency scale can describe how easily the poem is understood. How much the poem leaves space for self-interpretation and so called "white space". Here the transparent poems are typically easy to understand but might have a lack of white space for free interpretation, whereas the opaque poems are difficult to understand because of the amount of white space. In human behavior the transparency applies to a person, whose actions are easy to read, and transparency can be related to someone with openness and trustworthy. Whereas opaque can be referred to someone mysterious with hidden purposes. How do we understand and read the visual arts? Can we categorize it the same way as in literature with the transparency-opaque scale? Is there always this "white space" for interpretation? Although the understanding of art is always a subjective matter, we can still try to analyze it with the tools we have been given. Is it abstract or figurative? Is the composition stable or dynamic? Is the piece two or three dimensional? The size, the shape, the colour, and the title. And maybe it can be measured on the transparency-opaque scale too, or how much there is space for interpretation?

The materiality of the piece also plays an important role. How would it look if for example my work was made from wood or concrete, instead of glass and porcelain? It may have lost its sense of fragility. The chosen material has also a strong connection to its so called “roots”, for example glass and porcelain as a tableware, and concrete, and wood as a building material. These “labels” can affect the way we see the piece, because of their connection to something connectable. Du Preez’s paper takes an example of the Anton Karstels work of a police car (Fig. 13), which is crashed and flatten. It is printed out as photographs and laid down as an installation. The technology and photography have allowed us to make art in a different way, moving away from the traditional paintings and sculptures. Although this piece is powerful as it is, I cannot help myself to wonder what it would be as the real thing? To touch it, see the metal that is flattened and let it communicate through its materiality. To smell the metallic scent and see how the light scatters from it slightly uneven surface.



Fig.10 Anton Karstel, Wild thing, 2004 © Courtesy of artist and Visuality/Commentary Exhibition Catalogue (UP)

In my view the communication, materiality, and translucency are all somehow connected. Communication can be translucent as well as the used material. The material communicates non-verbally through the various channels of structure, color, and composition. All this led me to think that the works as an artist is always an intra-personal conversation. It is part of the artist that is poured into the piece. Whether it's conscious or not, it is there. Memories, thoughts, personal philosophies, communicating through the form and materiality, leaving “the blank space” for audiences’ interpretation.



Fig. 11, Impossible Dream, wheel thrown porcelain, (batch MBT1-A) © Marika Brandt

2.1 METHODOLOGY AND MATERIALS:

My methodology is practice based research. I have created and analysed different porcelain compositions to find the composition that would give me the results for good workability and translucency. I have used these porcelain compositions in my artistic research and art making. In my previous studies I focused on making the porcelain more plastic and suitable for wheel throwing. For my thesis I have continued this process, adding the aim to increase the translucency. The translucency is one of the things that characterises porcelain, and an important quality for my artistic work. In my studies I have compared different compositions and tried to change the amounts of the raw materials, to understand each one of them better. With the scientific analysis I have compared my own porcelain recipes to the commercial porcelain called Diez SAF, which is the porcelain that has the highest plasticity on the Portuguese market. I have used the same firing schedule and the same kiln for all the analysed batches. All the pieces were fired at 1280 °C with 20 minutes soaking time.

The firing temperature plays an important role for porcelain making and for me this was the challenge. During the studies for the thesis, I only had access to a kiln (size 20x20x30 cm) that would go to maximum 1280 °C, according to the controller. This temperature is not exactly what I would have desired, which would have been minimum 1300 °C. The kiln temperature turned out not to be accurate either, therefore I used the Bullers control discs (BPCD medium temperature 1050-1320) to measure the actual temperature in the kiln. The test showed that temperature was in the most parts almost 30 degrees lower than the controller displayed. The measured temperature was 1251 in the back and the middle front, and the disc that was placed on the bottom front measured temperature higher than 1320. The control disc that measured off the chart temperature was also grey in its colour, which is what happened to some of my samples as well.

The main ingredients for the porcelain I have chosen to make are kaolin, feldspar, and silica. I have chosen to use both bentonite and ball clay as a plasticiser and compared their properties in my studies. I wanted to see if the plasticiser affects the translucency and the colour of the porcelain. I have tried to increase the amount of flux and silica to see what combination gave the best translucency. I have also made comparisons between the different fluxes; potassium feldspar and sodium feldspar, to see if they had impact on the firing temperature, whiteness, or the translucency.

I have analysed the porcelain compositions with different analytical methods, such as linear contraction to measure the shrinkage and the absorption test, which measure the porosity and the water absorption. Linear contraction also tells us of the plasticity of the porcelain and the higher the shrinkage value, the higher the plasticity. The absorption test shows us if we have reached the firing temperature where porcelain is fully matured and reached zero porosity and absorption.

The compositions were analysed also with colorimetry Cielab parameters and with the reflectance spectra, to measure the whiteness. I made 6 samples, (3 with 1mm in thickness and 3 with 2 mm in thickness), of each composition and they were taken from the different parts of the paste to get the most correct results. These samples were also used to see the translucency. Since results for each composition were very coherent, I only picked one measurement from each thickness per composition for the reflectance spectra chart.

For the Dilatometry, X-ray diffraction spectroscopy and differential scanning calorimetry (DSC) analysis I picked the samples from group 4 (MBT4-A and MBT4-B), MBT5 which was based on the previous ones and the commercial porcelain Diez. Even though MBT4-A had been the most translucent and with good workability so far, I wanted to examine the MBT4-B to see the difference between these two compositions, which are almost identical, in order to better understand what is happening within the porcelain body.

Dilatometry shows us the thermal expansion and temperature when quartz changes its structure from α -quartz to β -quartz. This is the "point of no return". After this point the porcelain will not dissolve in water anymore. Dilatometry shows how compatible the compositions are. This is useful information in glassmaking since you want the batches to be coherent, so one for instance, can use different colors in your work. In ceramics the different types of porcelain would be mixed together, before making the piece, which makes them compatible.

The samples for the DSC analysis were dried raw porcelain, and they were fired during the time they were analysed. The DSC shows us in which temperature the chemical water is removed from the porcelain body, and the changes in the kaolin structure; from kaolinite through metakaolin and spinnel to mullite. The DCS analysis shows us again “the point of no return” where quartz changes its structure, and the porcelain will not become a raw mass again.

X-Ray Diffraction (XRD) is a laboratory-based technique commonly used for identification of crystalline materials and analysis of unit cell dimensions. The samples for the XRD were fired at 1280C° with 20 minutes soaking time. Afterwards they were grinded and analysed to see which crystals were formed in the porcelain body, for us to see if the different compositions made a difference for the crystal forming.

In my artistic work I have produced porcelain which required the good plasticity and translucency to support my artistic concept. I have also used borosilicate glass, which is flameworked and combined with porcelain. The transparency, translucency, opacity and the nonverbal communication have become an important part of my work. How do we look at artwork and interpret it? How does the materials ability to pass through the light affect the sense of fragility? The communication between the pieces in a bigger context. The memories that I try to understand, through the slightly animated and figurative style, while trying to give each piece a voice.

3.1 MAKING PORCELAIN

My starting point for making porcelain was to produce translucent porcelain with good workability. The good workability refers to a plasticity that allows the porcelain to be used on the pottery wheel. The compositions, (The names start with MBT) where the goal was to reach a good plasticity and translucency, were based on my previous studies (**Table 1**), where I had increased the plasticity, since the commercial porcelain on the Portuguese market is not very suitable for the potter’s wheel. In the study where I increased the plasticity, I compared batches A, B, C and D to the most plastic porcelain on the Portuguese market from the producer called Vicente DieZ. (**appendix p.28, Table 5**)

From my research I knew that the amount of feldspar should be relatively high to produce a translucent porcelain. From batch C I learned that only 5% of bentonite gave enough plasticity to the porcelain, so it could be worked on the wheel. The only problem with bentonite is that it might give problems during drying and therefore cause cracking.¹⁴ I also noticed that the amount of kaolin could be as low as 40% (Batch A). In batch D, the workability was good, but it didn’t seem very translucent, although during this study it was not the intention either.

TABLE 1: COMPOSITIONS MADE TO INCREASE THE PLASTICITY:

Ingredients:	Batch A (D Rodhes)	Batch B (EKWC)	Batch C (D. Leach)	Batch D (M. Brandt)	Comercial porcelain Vicente Diez	Comercial porcelain Vicente Diez
Kaolin	40%	45%	53%	50%	SiO ₂	63.13 %
Ball Clay	10%	4%		5%	Al ₂ O ₃	25.67%
Bentonite		1%	5%	5%	Fe ₂ O ₃	0.43 %
Potassium Feldspar	30%		25%	15%	CaO	0.30 %
Nephelin Sienite		15%		10%	MgO	0.06 %
Quartz	20%	30%	17%	15%	Na ₂ O	1.51 %
Paper pulp		0,5%			K ₂ O	1.06 %
Molochite		5 %			TiO ₂	0.09 %

I used the same kiln for all the samples in the analysis. As the kiln atmosphere can affect the results too, I wanted them to be as coherent as possible. The ideal firing temperature would have been at least 1300 °C degrees, but by that the time (when) the analysis was made, I didn't have access to a kiln which could reach this temperature. The samples were set to be fired at 1280 °C. The firing became the challenging part of the studies, as was explained before. The Bullers control discs test (BPCD medium temperature 1050 °C -1320 °C) showed that the temperature in the kiln was in the most parts almost 30 degrees lower that what the controller said and what I had hoped for. So actually, the samples were only fired to 1250 °C, which is quite a low temperature for porcelain.

All the compositions (**Table 2**) for my thesis study (aiming for good plasticity and translucency) are named as MBT (Marika Brandt Thesis). The number explains of which the compositions were created. I wanted to compare the difference between the plasticisers bentonite and ball clay. In each composition A indicates bentonite and B indicates ball clay. This way I could compare their capability to affect the plasticity and to see if they had effect on the translucency or the whiteness.

I chose potassium feldspar as the primary flux on the compositions, but I also made comparison between the potassium feldspar and sodium feldspar. Compositions where I used sodium feldspar are marked with (s) after the letter that indicates the plasticiser. Sodium feldspar has a slightly lower melting point and I thought that would get us closer to the zero porosity and therefore also become more translucent.

To achieve the translucency, without too much warping it was important to have the right amount of feldspar and silica. More silica gives less warping. All the different compositions were created in order to find the correct balance between silica and feldspar, which would then guide me towards the best translucency and a good plasticity.

TABLE 2 THE COMPOSITIONS MADE AIMING FOR GOOD PLASTICITY AND TRANSLUCENCY

Ingredients:	MBT-1A	MBT-1B	MBT1-As	MBT1-Bs	MBT-2A	MBT-2B	MBT-3A	MBT-3B	MBT-4A	MBT-4B	MBT-5	Diez	Diez
Kaolin	50%	50%	50%	50%	45%	45%	45%	45%	40%	40%	40%	SiO ₂	63.13 %
Bentoni te	5%		5%		5%		5%		5%		3%	Al ₂ O ₃	25.67 %
Ball clay		5%		5%		5%		5%		5%	5%	Fe ₂ O ₃	0.43 %
Potassium feldspar	25%	25%			30%	30%	25%	25%	35%	35%	35%	CaO	0.30 %
Sodium Feldspar			25%	25%								MgO	0.06 %
Quartz	20%	20%	20%	20%	20%	20%	25%	25%	20%	20%	17%	Na ₂ O	1.51 %
												K ₂ O	1.06 %
												TiO ₂	0.09 %

3.2. RESULTS AND DISCUSSION

The first compositions (MBT-1A and MBT-1B) were exactly equal apart from the fact that I used different plasticizers. In my opinion the MBT-1A is a good to work with. It has a good plasticity, which allowed me to model the porcelain in a way that is quite challenging for porcelain. For example, the **Fig. 12** This would not be possible with the clay or porcelain that does not have a good plasticity. MBT-1B was not plastic enough to be worked at. It was not suitable for the wheel and even sample making was not easy. The samples were fired up to 1280 °C. degrees, which was not high enough temperature to reach the zero porosity. Again the real firing temperature have only been 1250 °C



Fig.12 This piece is made from MBT1-A and shows an example of the plasticity that my work required. © Marika Brandt

On the next two compositions, the recipe was completely equal except that I switched the potassium feldspar with the sodium feldspar. They are marked as MBT1-A(s) and MBT1-B(s), with (s) indicating the sodium feldspar. Sodium feldspar has a slightly lower melting point and I thought that would get us closer to the zero porosity and therefore also become more translucent. The absorbance study shows that the sodium feldspar influenced the absorbance, and the samples came closer to the zero porosity. What I did not expect was that the sodium feldspar also influenced the linear contraction. The linear contraction was higher on the samples with sodium feldspar which then indicate that they were more plastic.

I kept the same amount of plasticisers (5%) in the next 6 batches, where A and B would be equal except for the plasticiser (A bentonite and B ball Clay). In MBT2-A and MBT2 B Kaolin was reduced to give more space for feldspar. The amount of feldspar was increased to 30 %. Again, I came across the same problem as before that sample B (with ball clay) was not plastic enough to work with. The samples MBT3-A and MBT3-B were decreased the feldspar to 25% again and increased the silica amount to 25%. This change made the porcelain very stiff, and especially the sample MBT3-B was not workable at all. The MBT4- A and MBT4-B, the kaolin was reduced to 40 %, feldspar increased to the 35 % and silica was back on 20 %. The plasticity problem was the same as before. Only 5 % of ball clay (Sample MBT4-B) was not enough to give a good workability. The batch MBT4-A was good to work with, as were all batches where 5% bentonite was used as a plasticiser. The samples in group 4 also reached the zero porosity at 1280 °C and were much more translucent than the other groups. Again, it seemed that the sample with ball clay was just firing a hint whiter.

The last composition I made was MBT5, and I used the knowledge I had gained from the previous compositions, and as the best translucency was received with the group 4, I based the last composition on this. The kaolin was kept on 40 % and the amount of feldspar on 35 %. I chose to use both ball clay and bentonite, because I wanted to see if the higher silica content in ball clay, would influence the translucency and the whiteness. I chose to use 5 % of ball clay and 3% of bentonite, which caused me to reduce the silica amount. MBT5 was good to work with and throw on the wheel. This composition allowed me to throw very thin (which is not so easy on porcelain).

All the compositions (**Table 3**) and the commercial porcelain Diez were analysed with the absorption test, the linear contraction test, and the colorimetry reflectance spectra. All the compositions were fired to 1280°C, with 20 minutes soaking time, and by using the same kiln.

Table 3 Linear contraction and absorbance

	MBT-1A	MBT-1B	MBT1-As	MBT1-Bs	MBT-2A	MBT-2B	MBT-3A	MBT-3B	MBT-4A	MBT-4B	MBT-5	Diez
Linear contraction when fired 1280 °C	15%	12,5%	16,5%	15%	15,5%	14%	16%	12,5%	16%	15%	15%	14%
Absorbance when fired 1280 °C	4.2%	5.1%	2,1%	4.3%	3.6%	4.3%	4.4%	3.8%	0%	0%	1.8%	2.2%

UV-VIS reflectance spectroscopy

UV-Vis Reflectance spectra shows the light that is reflected from the test pieces. All the samples were compared to the commercial porcelain Diez. The average measurement was gained by measuring each sample from three times from different parts of the sample. Higher reflectance percent indicates lighter colour of the sample.

According to the UV-Vis reflectance spectra the MBT1-B had the highest reflectance percent, and therefore the whitest colour as well. This shows that ball clay fires whiter than bentonite, but as mentioned before the 5 % of ball clay is not enough to give the needed plasticity for the porcelain. The whitest results and the best workability were gain from the batch MBT1-A.

Regarding the feldspars, the study shows that actually sodium feldspar does not fire whiter than potassium feldspar, but in fact the opposite.

Colorimetry – CIELab

Porcelain samples, fired at 1280 °C. with 20 minutes soak at the maximum temperature (Measuring 3 samples of each batch, with 3 measurements each)

L = Brightness

A = Green – Red

B = Yellow – Blue

In the CIELab test the brightest value was gained from the MBT1-B (**Table 4**) which is the same result we got from UV-VIS reflectance spectra. On the green-red, blue-yellow scale the MBT2-A (**Fig.12**) was closest to the centre and therefor the whitest.

Table 4 – CIELab

	MBT-1A	MBT-1B	MBT1-As	MBT1-Bs	MBT-2A	MBT-2B	MBT-3A	MBT-3B	MBT-4A	MBT-4B	MBT-5	Diez
L a b	L: 81 a: 0.47 b: 4.76	L: 88.84 a: 0.54 b: 7.19	L: 77.96 a: 0.5 b: 5.65	L: 71.6 a: 0.65 b: 4.98	L: 71.24 a: 0.5 b: 3.64	L: 73.9 a: 0.41 b: 4.08	L: 80,3 a: 0.43 b: 4.29	L:84.84 a: 0.32 b: 6.16	L: 78.83 a: 0.32 b: 5.44	L:81.33 a:0.29 b: 5.27	L: 81.29 a: 1.1 b: 5.07	L: 78.9 a:1.1 b: 6.1

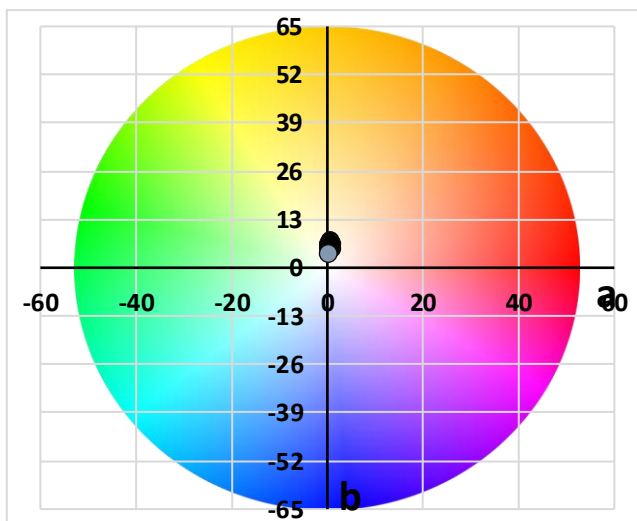


Fig.13 CIE Lab chart

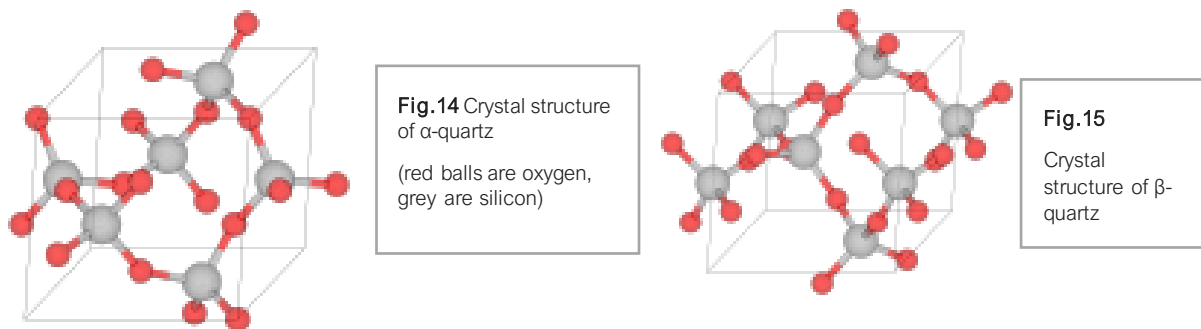
DILATOMETRY, DSC- differential scanning calorimeter, XRD

For the dilatometry, XRD and CDS analysis the following samples were picked: MBT4-A and MBT4-B, MBT5 (which is a composition based on the previously mentioned ones) and the commercial porcelain Diez. Even though MBT4-A had been the most translucent and with good workability, I was curious to see the MBT4-B as well, to understand better what is happening with the porcelain body.

The Dilatometry shows us that the samples selected for this analysis were very coherent. There are just small differences on the thermal expansion and in which temperature the quartz changes its structure. (Appendix p.31-32, Fig. 24, 25, 26, 27)

The samples for the DSC analysis were dried raw porcelain, and they were heated up during the analyse. From the DSC curves (Appendix p.33, Fig. 28, 29, 30, 31) it can be seen how the chemical water is removed from the porcelain body from around 450 °C – 600 °C degrees.

The dehydration of kaolinite clays cause the peak in thermal curves at, or near, the range of 500 °C to 550°C. This is also affected by particle size of the kaolinite clay. The smaller the size kaolinite distribution, gives narrower width of the DSC peak. The DCS analysis shows us again “the point of no return” where quartz changes its structure (**Fig 14 and 15**), and the porcelain will not become a raw mass again.



When kaolin is heated to 925–950 °C, the metakaolin that it has become after dehydration, converts to an aluminium-silicon spinel. This can also be seen in the DCS chart (Fig.) The calcination happens above 1050 °C, where the spinel phase begins to transform crystal forms as mullite and cristobalite.

The X-ray diffraction analysis shows us very coherent results between the 4 different types of porcelain. they behave very similarly even with different compositions and by using different ingredients. The results were compared to the XRD patterns obtained from the paper “Whiteness improvement of porcelain tiles incorporated with anorthite and diopside phases,” Tarhan ,2019. (**Fig.17**)

The translucency is achieved when the ingredients are sintered, and the different crystals are forming in the porcelain body. Different crystals have different refractive index values and therefore they cause different effect on the translucency. Crystal grains scatter the light differently as for example cubic crystals the light is only scattered on the grain boundary, letting the light pass through making the porcelain translucent. The crystal formations are affected by the temperature and the composition. Anorthite crystal formation increases the translucency because of its low refractive index, which is close to glass.¹²

It confirms that the porcelain compositions have all formed mullite and quartz crystals. Quartz crystal has the large peak between 25-30° and again a smaller one at 50°, Mullite peak is the first one we see after 15° and then again around 35°. (**Fig.16,18,19**) All this information confirm that it is actually porcelain which we have produced. It was expected to observe anorthite or albite crystalline phases, which influence the translucency of porcelain, however they are not present in the XRD patterns. (**fig. 16**). However, these crystalline phases may be present in the developed samples in a low concentration. Therefore, to confirm these results further studies need to be performed, as for example the composition determination of the developed porcelains and to do Scanning Electron Microscopy (SEM) analysis.

In the future studies, it would be necessary to know the exact compositions of each raw material, in order to know for example, the presence of calcium. It would be interesting to try replacing some of the feldspar with calcium-based flux, in order to increase the formation of anorthite crystals in the porcelain body and study its effect on translucency.

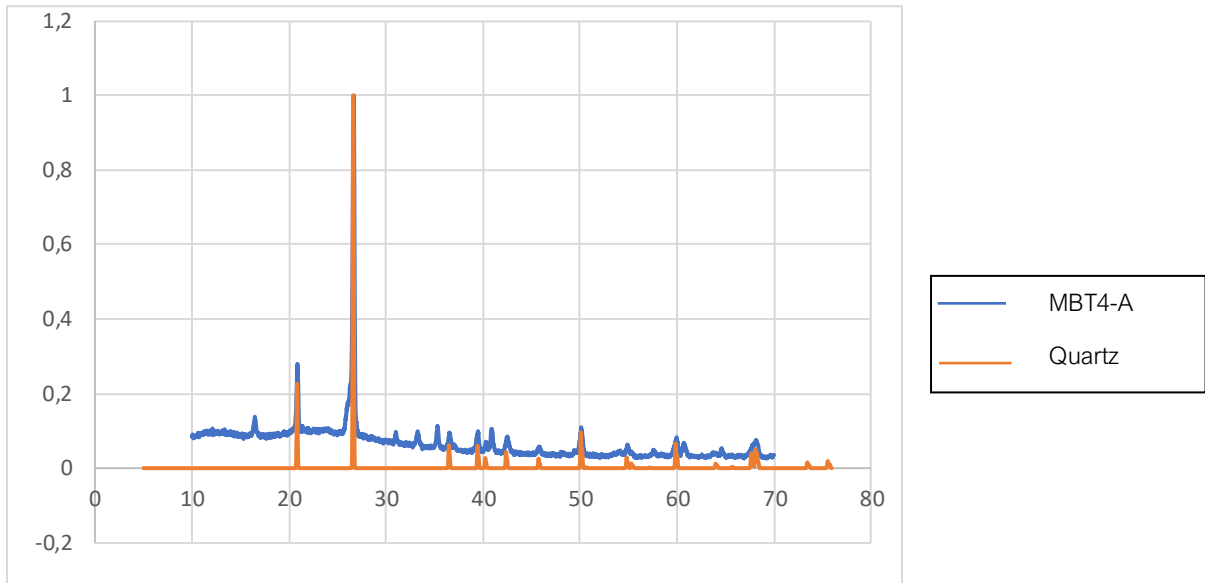


Fig. 18– XRD results that confirms the quartz crystals³⁰

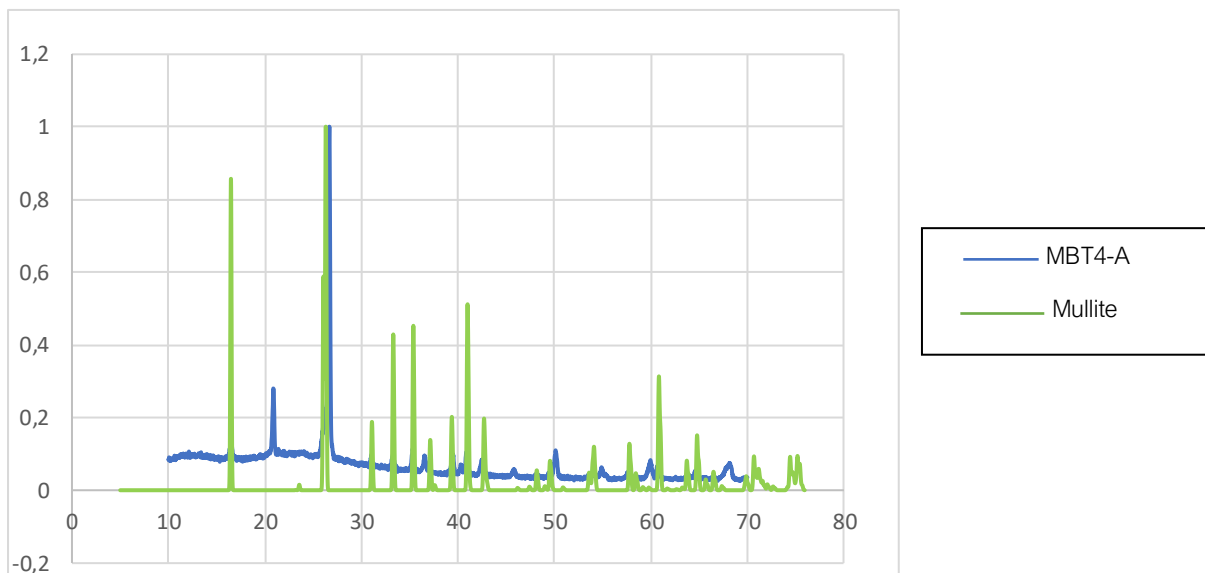


Fig.19– XRD results that confirms the Mullite crystals³¹

³⁰ [Quartz R100134 - RRUFF Database: Raman, X-ray, Infrared, and Chemistry](#)

³¹ [Mullite R141101 - RRUFF Database: Raman, X-ray, Infrared, and Chemistry](#)

3.3 CONCLUSION

“Somewhere between the waves is the blank space” is an intrapersonal conversation, that invites the reader and the viewer in, letting them to create their own interpretation of the work. The artworks communicate through their form, structure, composition, and materiality, whereas the written research supports this journey.

My thesis study is a direct result of a curiosity that started around two years ago. Just a simple question directed to my professor (and thesis supervisor) if I could throw porcelain on the wheel, is what started this journey. The realisation that the commercial porcelain available in Portugal was not suitable for this technique due to lack of plasticity, led me into further questions to know if there was a way, I could produce it by myself.

Before starting my thesis work, I had already worked with porcelain where I increased the plasticity within the material. This made the porcelain more suitable for wheel throwing and allowed me to make my artistic work with use of this technique. In my thesis project, I continued to develop porcelain recipes, aiming for a porcelain that was both translucent and plastic enough for wheel throwing. Two qualities that required kind of opposite compositions, and where you have to find the right compromise somewhere in between.

In my studies I have probably raised more questions than found answers, as the artistic research goes hand in hand with the scientific research. I have searched for the perfect recipe that would serve the artistic purpose as well as worked with the material that has such a long and even violent history, that even involves slavery. There are endless possibilities, and this will most likely be the path of the lifetime.

I have produced porcelain which required the good plasticity and translucency to support my artistic concept. The scientific research and my artistic practice showed that the recipe MBT4-A is the most translucent recipe, with the good workability. I also use the recipe MBT1-A in the pieces, where the translucency does not play the key role. There is a lot of ways I could continue my research and probably the next step would be trying to increase the anorthite crystal formation by adding a calcium source, in order to receive higher translucency, while keeping the good workability. It would be also interesting to work with the whiteness by adding titanium oxide, like they have done in the commercial porcelain.

The thesis work has broadened up my view about my own work and also given some clarity of why I am doing what I am doing. Why there always seems to be this fragility, and the constant search of stability? Whether is in relationship or surroundings that I try to process through the animated and figurative style. Where the materiality, and intrapersonal communication plays a part. The transparency, translucency, opacity, and the nonverbal communication have become an important part of my work. How do we look at artwork and interpret it? How does the materials ability to pass through the light affect the sense of fragility? The communication between the pieces in a bigger context. The memories that I try to understand, through the slightly animated and figurative style, while trying to give each piece a voice.


Sometimes it does not take many minutes or even seconds to decide to what you want to do, and I tend to think that those choices are made by heart. Choices that are the right for us. Even when the path is unknown, our gut feeling can tell us the way. Choosing the thesis subject was one of those choices for me. A choice that has kept me curious for some time now, and there does not seem to be an end in the horizon. For the same reason it has been hard for me to draw the line on when to stop, when something is in constant progress. Where should I put the ending mark? Or should we say, to be continued with? This said while I am standing on the first steps on the path that I have chosen.

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31. [Mullite R141101 - RRUFF Database: Raman, X-ray, Infrared, and Chemistry](http://rruff.info)

4. Appendix

Table 5 – Technical Data sheet for commercial porcelain DIEZ SAF XTR

 <p>Vicente Diez arcillas minerales y pastas cerámicas clays minerals and ceramic bodies</p>	<table border="1"> <tr> <th colspan="2">PRODUCTO / PRODUCT</th> </tr> <tr> <td>SAF XTR Porcelana extrusionada Wrapped porcelain (1260-1300°C)</td> <td>Porcelana blanca adecuada para modelado y torneado. Extra-white porcelain for modelling and throwing</td> </tr> </table>	PRODUCTO / PRODUCT		SAF XTR Porcelana extrusionada Wrapped porcelain (1260-1300°C)	Porcelana blanca adecuada para modelado y torneado. Extra-white porcelain for modelling and throwing																						
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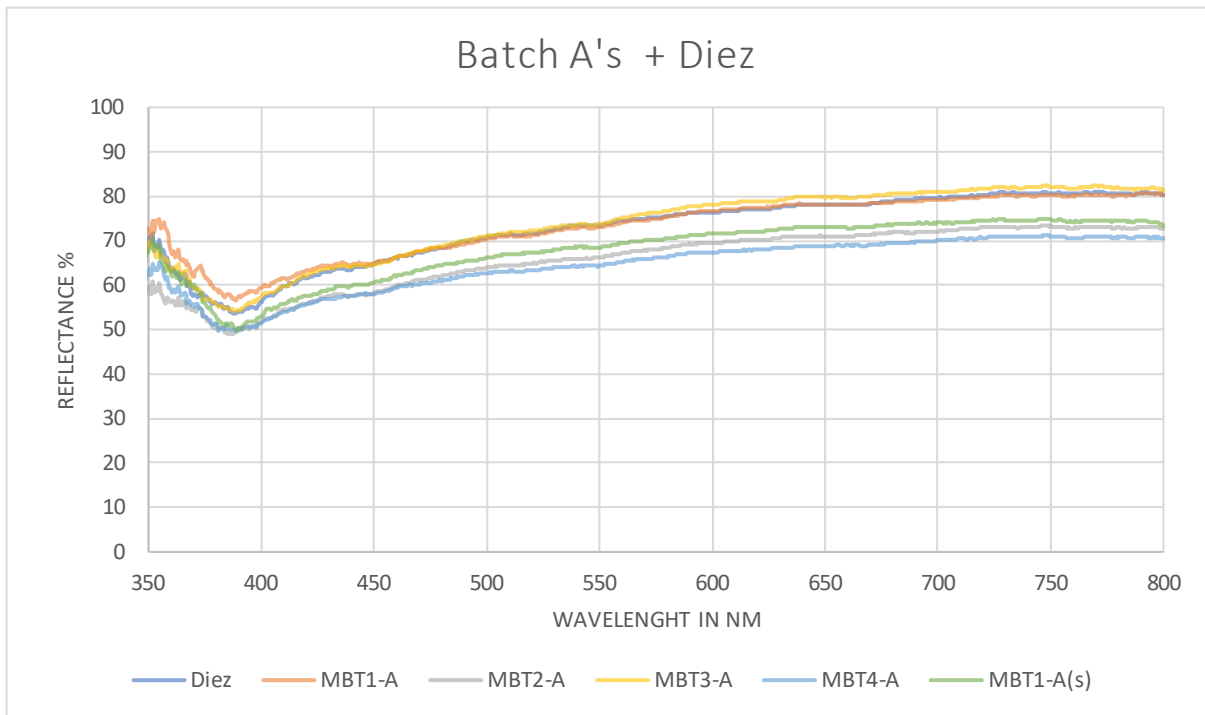


Fig.20 UV-Vis reflectance spectra, Batch A's (with bentonite as a plasticiser) compared to Diez

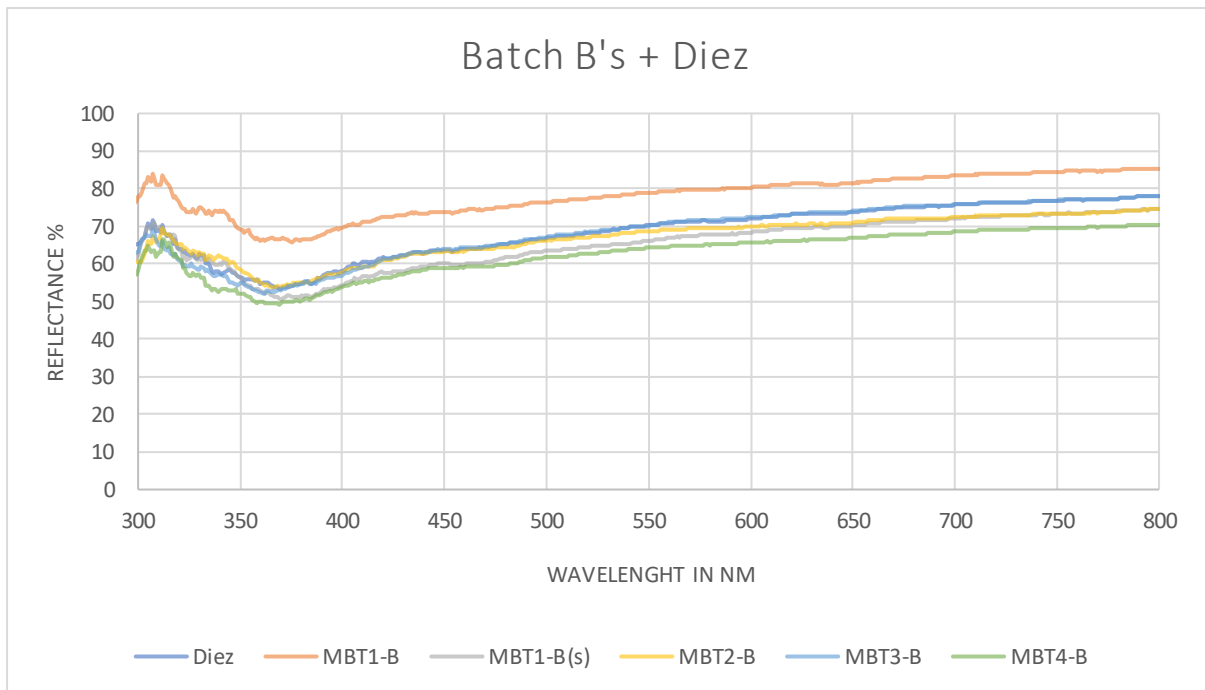


Fig.21 UV-Vis reflectance spectra, Batch B's (with ball clay as a plasticiser) compared to Diez

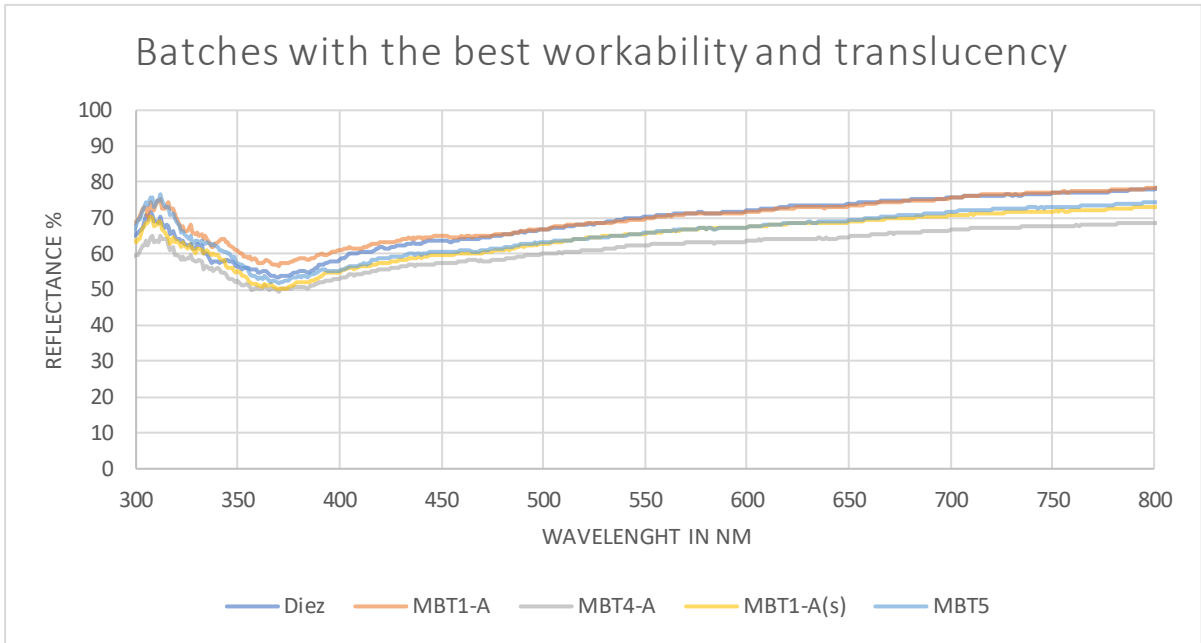


Fig.22 UV-Vis reflectance spectra – batches with the best workability and translucency compared to Diez

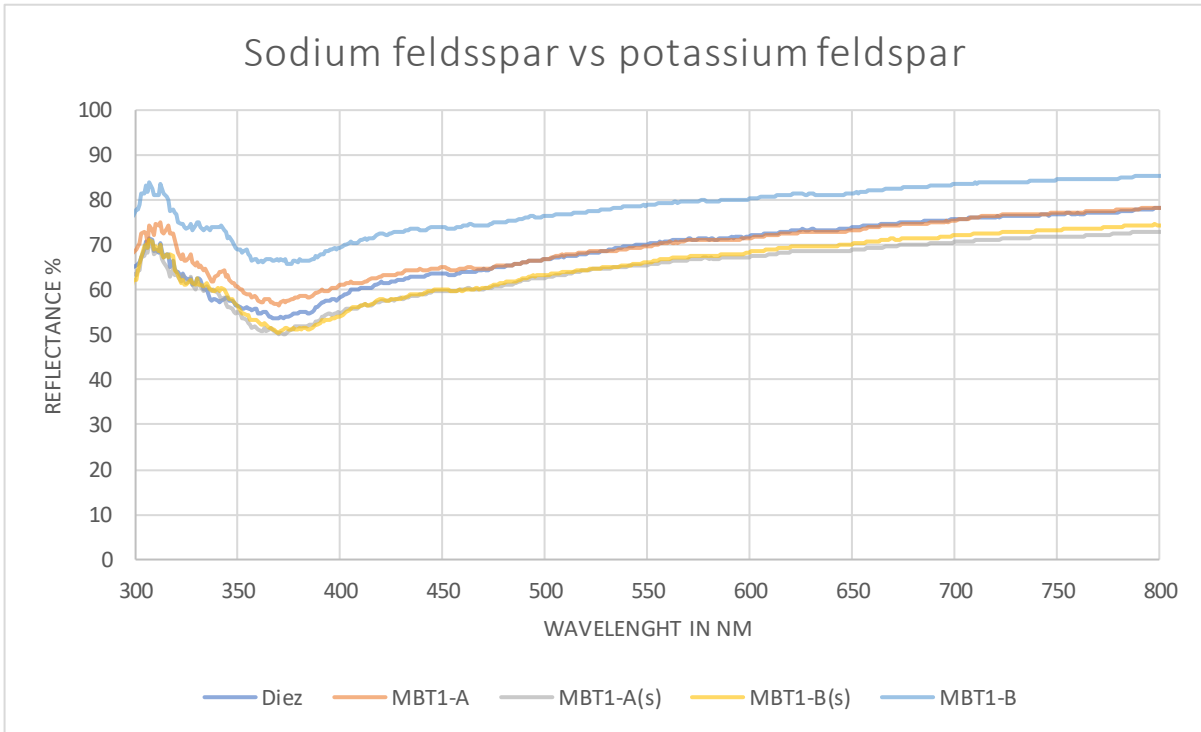
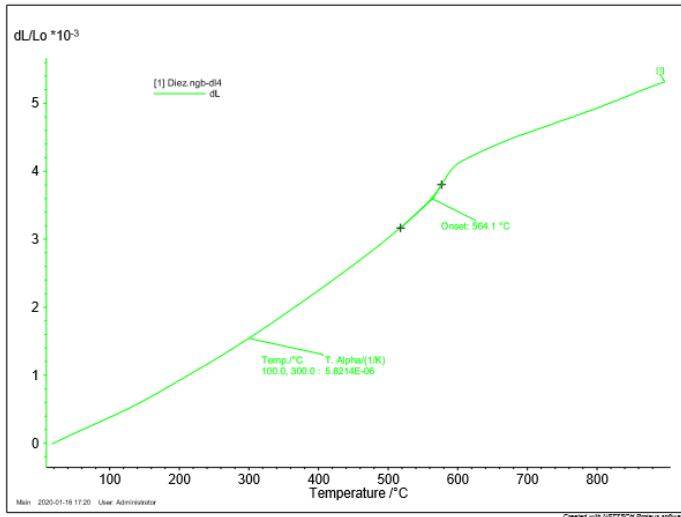
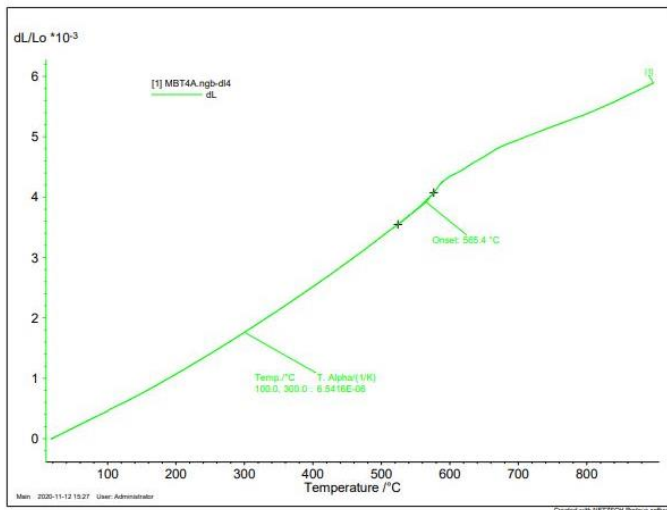


Fig.23 UV-Vis reflectance spectra, comparing batches that are identical except for their plasticiser and the type of feldspar. All of them are compared to the commercial porcelain Diez.



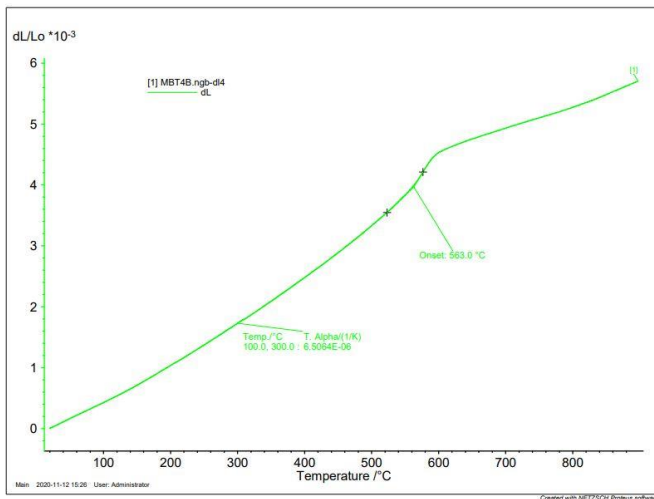
Diez: Onset: 564.1 $^{\circ}$	
Temp./ $^{\circ}C$	T. Alpha/(1/K)
100.0, 300.0	5.8214E-06

Fig.24 Dilatometry results - DIEZ



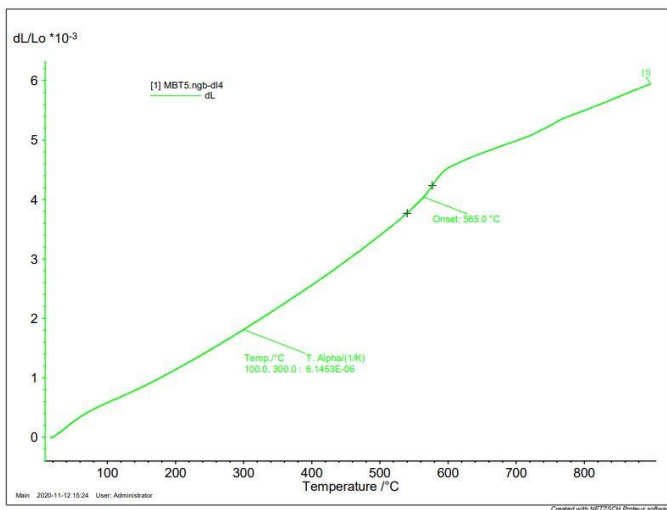
MBT4-A: Onset: 565.4 $^{\circ}C$	
Temp./ $^{\circ}C$	T. Alpha/(1/K)
100.0, 300.0	6.5416E-06

Fig. 25 Dilatometry results – MBT4-A



MBT4-B Onset: 563.0 $^{\circ}C$
 Temp./ $^{\circ}C$ T. Alpha/(1/K)
 100.0, 300.0 6.5064E-06

Fig.26 Dilatometry results – MBT4-B



MBT5 Onset: 565.0 $^{\circ}C$
 Temp./ $^{\circ}C$ T. Alpha/(1/K)
 100.0, 300.0 6.1453E-06

Fig.27 Dilatometry results MBT5

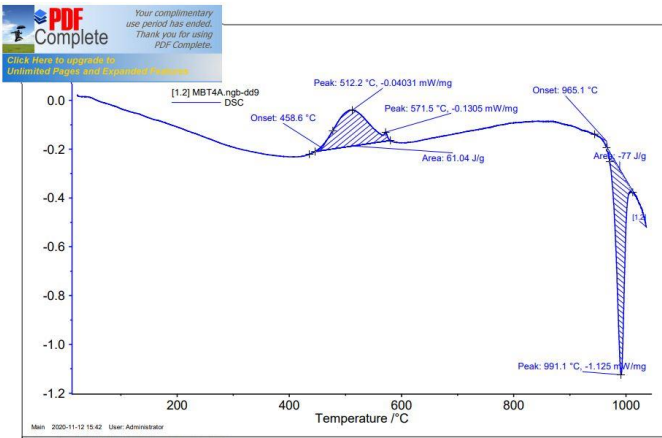


Fig.28 – DSC -MBT4-A

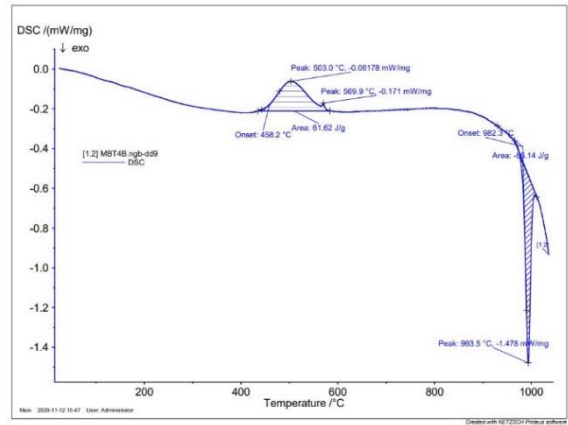


Fig.29 DSC -MBT4-B

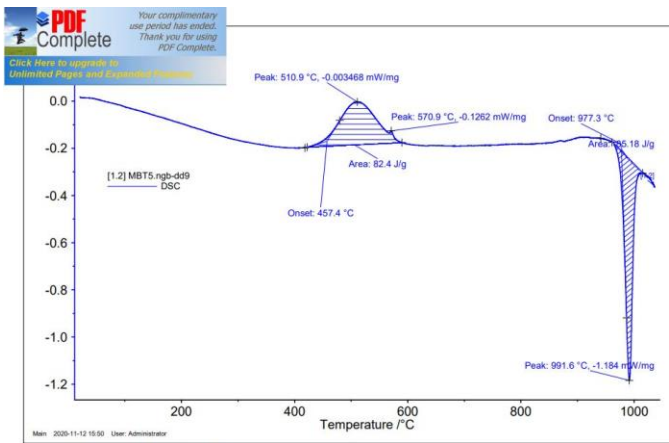


Fig. 30 DSC – MBT5

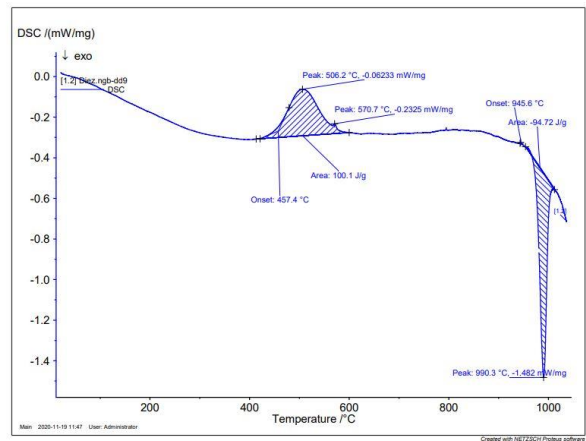


Fig. 31 DSC -DIEZ

