Robust Coating Process for Silica Glaze Material

Submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Hons.)

by

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Banchelor Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

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(DR SYAHRIZA BINTI ISMAIL)

ABSTRAK

Silika glaze adalah bahan yang digunakan dalam proses pelapisan untuk acuan sarung tangan mereka. Penggunaan silika glaze semasa pemprosesan adalah kerana bahan ini mampu menahan suhu tinggi dan tahan terhadap tindak balas asid. Semasa pembuatan sarung tangan, acuan tangan manusia dengan tekstur pegangan tangan, penting untuk menerapkan bahan glasir kerana silika glaze dapat menutup tekstur kasar. Sarung tangan yang dihasilkan menghadapi masalah lubang. Masalahnya dilaporkan berlaku kerana pengumpulan serbuk di antara jari-jari acuan. Pengumpulan serbuk berasal dari bahan kimia yang digunakan. Objektif projek ini adalah untuk menilai lapisan silika glasir di antara bekas jari dengan menggunakan kaedah span Polyvinyl Alkohol (PVA) untuk menghilangkan kekasaran permukaan dan untuk mencirikan silika pada bekas bersalut dan tidak bersalut menggunakan analisis SEM dan XRD. Projek ini memutuskan untuk mereka bentuk bola kecil seperti span kerana kawasan yang ingin dilapisi oleh projek ini sangat kecil apabila bola kecil seperti sponge jauh lebih mudah untuk menekan kawasan itu sahaja. Untuk mendapatkan permukaan yang lebih baik, projek ini tidak boleh menggunakan keliangan tinggi kerana tekstur span dapat diterjemahkan menjadi bentuk keliangan ke permukaan. Untuk membandingkan kekasaran permukaan sebelum dan selepas menggunakan silika glaze menggunakan analisis SEM. XRD digunakan untuk membandingkan komposisi bahan sebelum dan sesudah menerapkan silika glasir, puncak, intensiti dan peratusan perubahan bahan, dari XRD kepekatan silika oksida bekas terlapis adalah tinggi dibandingkan dengan bekas tidak bersalut. Aluminium oksida kepekatan dan peratusan bersalut tinggi berbanding dengan tidak bersalut. Gambar SEM menunjukkan kekasaran permukaan seramik dihilangkan dan dikurangkan dengan menggunakan silika glasir ini. Akhirnya, ujian sebelumnya di barisan pengeluaran menunjukkan hasil yang baik tidak ada serbuk yang terkumpul dan menghasilkan sarung tangan yang baik.

ABSTRACT

Silica glaze is the material applied in the coating process for their former or mold glove processing. The use of silica glaze during the processing is because this material is capable to withstand high temperature and inert to the acid reaction. During the manufacturing of surgical glove, the shape of the former as a human hand with the texture of the handgrip, it is important to apply the glaze material because silica glaze can close the rough texture. The surgical gloves manufactured is facing with pinholes problems. The problems are reported to occur due to the powder accumulation in between the former/mold fingers. The powder accumulation comes from the chemical used. The objectives of this project is to evaluate the coating of silica glaze at between fingers former by using Polyvinyl Alcohol (PVA) sponge method to eliminate the surface roughness and to characterize the silica glaze at coated and non-coated former using SEM and XRD analysis.. This project decides to design th e sponge-like small ball because the area that this project wants to coat is very small when the sponge-like small ball is much easier to tap that area only. To get a better surface finish this project cannot use high porosity because the texture of the sponge can translate into a surface finish. To compare the surface roughness before and after apply silica glaze using SEM analysis. XRD is use to compare the material composition before and after apply silica glaze, the peak, intensity and the percentage of the material change, from XRD the concentration of silica oxide of coated former is high compare to non-coated former. Aluminium oxide the concentration and the percentage of coated is high compared to non-coated. SEM image show the surface roughness of ceramic is eliminated and reduced by using this silica glaze. Finally, the former test at production lines it show the good result no powder accumulate and produced good gloves

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LIST OF ABBREVIATIONS

SEM - Scanning electron microscopy

XRD - X-ray diffraction

LIST OF SYMBOLS

%	-	Percent
~	-	Approximately
°C	-	Degree Celsius
mm	-	Millimetre

CHAPTER 1
INTRODUCTION

This chapter will introduce the background of the study as well as the problem statement, objectives, and scopes will further discuss the purpose of this research to be carried out.

1.1 Background of Study

Robust Coating Process for Silica Glaze Material is the industrial project during my internship at Top Glove Sdn Bhd. Silica glaze is the material applied in the coating process for their former or mold glove processing. The use of silica glaze during the processing is because this material is capable to withstand high temperature up to 1200°C and inert to the acid reaction. However, during the application of this silica glaze, some problems arise that affect the quality of the former. The problem is difficult to handle the glaze material since they used the technique of brush coating, the material reaches the point when using a brush and other problems do not get the homogeneous silica glaze distribution. Hence it is important to find the best way to coat in between the former finger when using this silica glaze material.

During the manufacturing of surgical glove, the shape of the former as a human hand with the texture of the handgrip, it is important to apply the glaze material. In this industry, silica glaze is applied to close the rough texture between the finger and make it soft for easily leach the powder during the cleaning process. A glaze is a thin vitreous layer formed on ceramic ware by application of superior materials and secured to the surface by firing at high temperatures. They are applied to bodies to make them impervious, mechanically stronger, and resistant to scratching,

chemically more inert, and more pleasing to the touch and eye. The raw materials for the manufacture of glazes can be grouped into three categories of flux, glass former (silica), and stabilizer (kaolin) (Norsker & Danisch 1993).

1.2 Problem Statement

Gloves are the main product manufacture by Top Glove. Recently, the surgical gloves manufactured is facing with pinholes problems. The problems are reported to occur due to the powder accumulation in between the former/mold fingers. The powder accumulation comes from the chemical used as the first layer at the former to get the latex to form the glove such as Calcium Nitrate, Calcium Carbonate, and Calcium Stearate. Besides, this former also has a critical area that is in between the finger because the gap is very small and the surface of the former very rough. Below is the diagram of the former.

Figure 1.1: former

The rough surface of the former caused the powder to easily accumulate. The surface is also difficult to clean and leach out the powder. The other factor that contributes to this problem occurred because of the weak cleaning process in between fingers. The texture of roughness is required in this former as the handgrip. Below is the Figure 1.2 of the texture former surface.

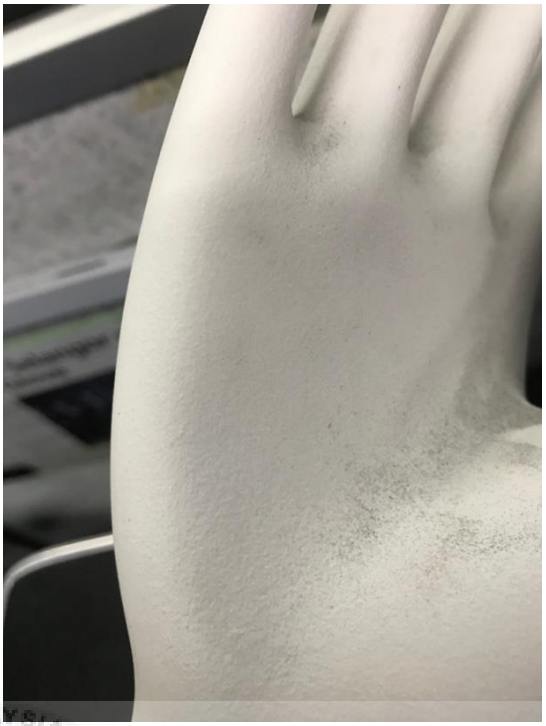

Figure 1.2: Texture former surface

Due to the powder accumulation problem, the study is conducted to find a solution on how to eliminate this problem. The idea is that to overcome the coating in between the former fingers by using silica glaze, in this work, the coating is used to prevent rough surface between the fingers and easily for powder leaching.

The method used to coat this substance is currently inappropriate because they used a brush to coat it. The issues arise when using the brush, inconsistent homogeneous silica glaze distribution, and eventually, it will affect the quality of the producing glove. My study is to close the inherent porosity at ceramic former and get the homogeneous silica glaze distribution.

1.3 Objectives

There are two main objectives for this research which are:

i. To evaluate the coating of silica glaze at between fingers former by using Polyvinyl Alcohol (PVA) sponge method to eliminate the surface roughness

ii. To characterize the silica glaze at coated and non-coated former using SEM and XRD analysis.

1.4 Scopes

This research is about to eliminate the surface roughness at between finger former and study the morphology of former after apply silica glaze. There are many methods of coating using silica glaze, such as dipping, spraying, and brushing the substance. In addition, this project needs to consider the design of between fingers because this project needs to coat at the critical part. The important thing is the material cannot exceed the area from the target. Furthermore, when coating the material of silica glaze is significant to get the homogeneous silica glaze distribution, get a better surface and close inherent porosity. This research try to design the sponge which is the best design to apply at between fingers and choose the suitable material of sponge. Thus, the effect is will produce problematic gloves if choose the wrong material and method of coating. This research need to compare the surface roughness and material composition at former before and after apply silica glaze using analysis Scanning Electron Microscopy (SEM) and X-ray diffraction (XRD)

1.5 Rational of Research

The rational of research are as follows:

i. The spraying is not the best method for this project since the spray is typically for wide areas, however in this work, only a small gap area is required to do the coating.

ii. Dip also is not acceptable in this project, as it will coat all the area. Meanwhile this project wants to coat at selected area only.

iii. Using a brush is an easy way to handle coat at a critical part but it will produce inconsistent thickness.

iv. The problem of this project will be solved by using a ball sponge technique from my research with a combination of theoretical and technical knowledge.

1.6 Research Methodology

This project consists of six crucial parts, the first is the chemical preparation of silica glaze material. Second, the ball sponge diameter is measured to be used as the current coating process at a small distance between the fingers. The way for using this ball sponge is only to tap on the area. Third, firing the former as a silica glaze curing process for 12 hours at a temperature of 1206 ° C. Fourth, testing the modified former in production lines. Fifth, data analysis and result for the quality glove. Sixth, observe the result from the glove where to do improvement as the conclusion. Below is the Figure 1.3 of the flowchart framework.

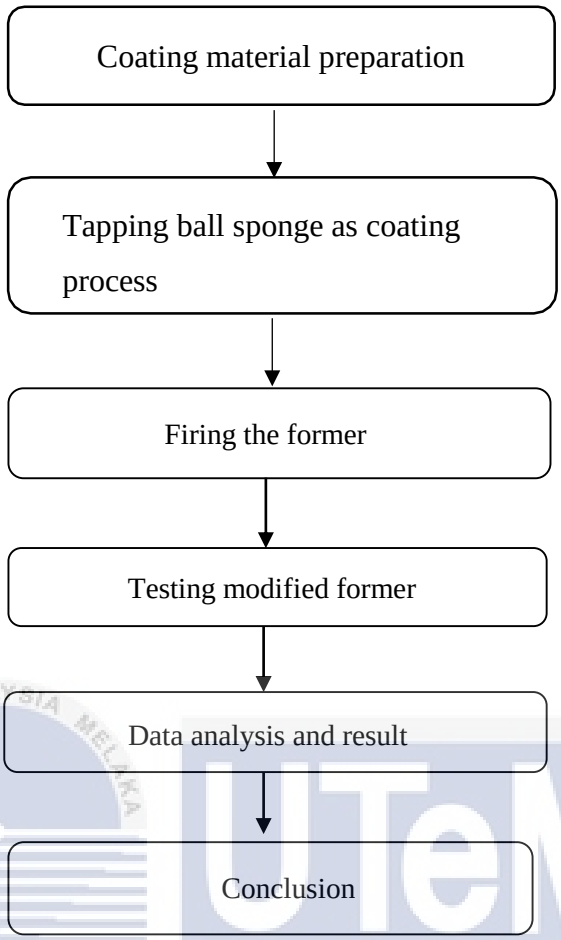

Figure 1.3: Flowchart framework

1.7 Thesis Organization

This thesis consists of five Chapters. Chapter 1 is the introduction which will cover the background study, problem statement, objectives, scope, and rational of research are portrayed to give a better understanding of the particular aspects of this study addressed in this thesis which followed by Chapter 2, the literature review to provide supportive findings on the same matter. Chapter 3 is the methodology applied to conduct this project followed by Chapter 4 which provides results and analysis of this study. Chapter 5 will provide the conclusion and recommendations executed from this project which will be needed for the betterment of the future studies

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction of Glaze

Ceramic glaze is an impermeable layer or coating of a vitreous material that by firing has been fused to a ceramic body. Glaze can be used to paint, decorate, or waterproof an object, to resist chemicals, to seal the inherent porosity, and to offer a tougher surface. Glazes can produce some surface finishes, including glossy types, in addition to their versatility, or matte finish and color (Olupot et al. 2006). Glazes need to have a ceramic flux that works in the clay bodies and the other glaze materials by facilitating partial liquefaction. The high melting point of the glass forms silica and often boron trioxide is reduced by fluxes. In the glaze materials, these glass formers may be used or can be taken from the clay (Dhir et al. 2018).

In general, the raw materials of ceramic glazes include silica, which would be the predominant former glass. Various metal oxides serve as a flux and thus lower the melting temperature, such as sodium, potassium, and calcium. Sometimes derived from clay, alumina stiffens the molten glaze to keep the piece from running off (Madan Gaurav, 2005). To alter the visual appearance of the fired glazed oxide, dyes such as iron oxide, copper carbonate or cobalt carbonate, and occasionally opacifiers such as tin oxide or zirconium oxide, are used. (Ceramic, 2011).

2.1.1 The Properties of Glaze

The firing temperature is critical in the description of any glaze. Thus high-temperature glazes fired between 1200 and 1400 °C are specially used for electroceramics, bone-china, and bone-porcelain (1250 °C) as well as fireclay products (fired between 1200 and 1250 °C). Medium temperature glazes are fired at 1000–1050°C and examples are earthenware bodies for tableware and tiles (Mazumder & Mishra, 2011). Gloss, satin matt, or a dry surface texture may be produced from the fired glaze. The glossy surface is shiny to the touch and smooth. With a semi-smooth surface texture, a satin matt surface is similar to a satin ribbon, while a dry matt glaze may have a gritty surface. It is not appropriate to confuse the surface texture of the glaze with its light transmission characteristics. Glazing enhances every ceramic vessel's entire clay body. The glazing ratio to the clay body is also determined by potters, so the fired glaze fits tightly on the ceramic surface, thus compressing the clay molecules. Compression results in greater resistance to liquids and increased durability of the object (Ashby & Jones, 2013). Glazed objects tend to last for hundreds of years due to their rigidity. Due to their loose clay molecules, unglazed objects are also easily broken.

2.2 Method of Glaze Coating

Glaze may be applied either by dry-dusting a dry mixture over the surface of the clay body or by injecting salt or soda at high temperatures into the kiln to create an atmosphere rich in sodium vapor using various methods. The atmosphere can combine to shape and deposit glass with the aluminium and silica oxides in the body, creating what is known as salt glaze pottery. In aqueous suspension, glazes of different powdered minerals and metal oxides are most commonly added by dipping parts directly into the glaze. Other methods involve pouring the glaze over the object, spraying it with an airbrush or similar instrument onto the piece, or applying it directly with a brush or other instrument.

2.2.1 Spray Glaze On

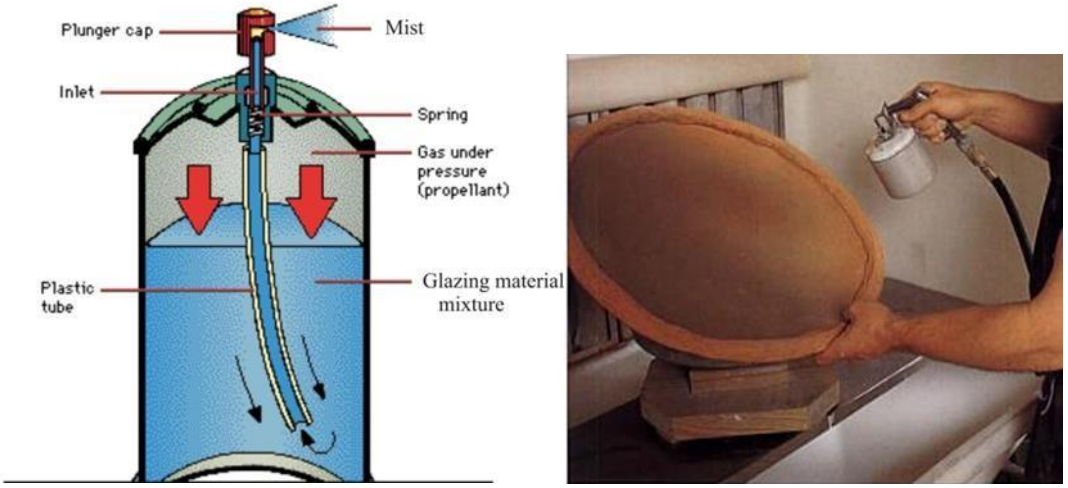

Figure 2.1: Spray Method

Spray guns and airbrushes are two devices used by potters to spray glazing on their pottery. When considering this option, caution should be taken on several counts. Without gumming up and being associated, the nozzles used must be wide enough to handle particulate glaze. For safety purposes, spraying glazes should always be done in a spray booth with sufficient ventilation (Sun et al. 2020). A well-maintained dual-cartridge respirator which is NIOSH/MSHA approved should always be worn whenever spraying any ceramic materials, including glazes

The benefit of using spray techniques is the vast amount of pottery that uses the same glaze. In a bucket, the glaze is combined, which promotes the volume of the glaze. Spraying allows for subtle colour variations and overglaze thickness and coverage control. Uses more glaze than is used to dip or pour. The limitation of these methods is that a large amount of glazing material is required. To properly cover the pieces while spraying, adequate glazing thickness is needed. When spraying glazes, a respirator and a protective eye goggle are required.

2.2.2 Dip Pots into Glaze

Figure 2.2: Dip Glazes process

Dip glazes are more fluid than brush application glazes. The consistency of heavy cream should be about a dipping glaze. To allow the correct amount of glaze to coat the pot, the ceramic ware will be suspended in the glaze for approximately three seconds. (Norsker et al. 1993).

Keep the pot so that the opening of the pot's mouth is level, using either your fingertips or dipping tongs. I use clear glass to keep the glaze in the photo so that you can see that the opening of the pot is parallel to the surface of the glaze. The pot is dipped into the glaze, indicating the right placement. Lower the pot two-thirds to three-quarters of the way into the glaze using a single, fluid motion, keeping it even. Do not allow the pot to touch the bottom or sides of the bucket or container, since this can rub the glaze coat off.

The advantage is the quickest glazing pottery techniques and offers an even glaze coating. Done with care, the pot's interior is left unglazed, allowing the inside to use a different glaze without overlaying the glazes. With heavyweight ceramic ware, the downside cannot be achieved because the weight can cause an upthrust that can cause the fluid to spill out of the jar. (Michael harvey, 2004).

2.2.3 Pour Glaze In and On

Figure 2.3: Pour Glazes process

Glazes need to have the same quality as dipping glazes for pouring and are mostly done in combination with dipping. Glazes can be easily poured into a pot for glazing interiors, left for three seconds, and quickly poured back into the glaze bucket. Any excess glaze can be flicked off using a sharp wrist rotation while holding the rim of the pot parallel to the surface, it can be cleaned off with a sponge or towel, or for its decorative effect, it can be left as it is. Glazes may also be poured over a pot's exterior surfaces. This is often achieved over the top of a base layer of glaze to add a thinner coat of glaze (Norsker et al. 1993). The two glazes will interact, at least to some degree, often resulting in a more interesting glaze with greater visual depth. Be careful not to mix different glazes if you are using different colors.