HOWARD WOON

HIGH PERFORMANCE FORMER FOR QUALITY DIPPING GLOVE

ABOUT THE AUTHORS

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ABSTRACT

This is a sequel to our 2016 IRGCE article on the ~ATTRIBUTES OF GOOD FORMER IN GLOVE MAKING. We focus on the making of high performance ceramic dipping formers with our understanding of ceramic's surface morphology.

Ceramic Materials: Kaolin, Feldspar, Quartz, Alumina are the core ingredients in the making of ceramic dipping formers and their selective mining and processing required a broader and in-depth sourcing base to ensure consistent material quality in the face of higher environmental and more stringent restrictions placed on the extraction and processing today. It is reckoned that greater emphasis will be placed in identifying and utilizing the most cost efficient ceramics materials to be used in making the formers. It is both a geographical and technical driven development.

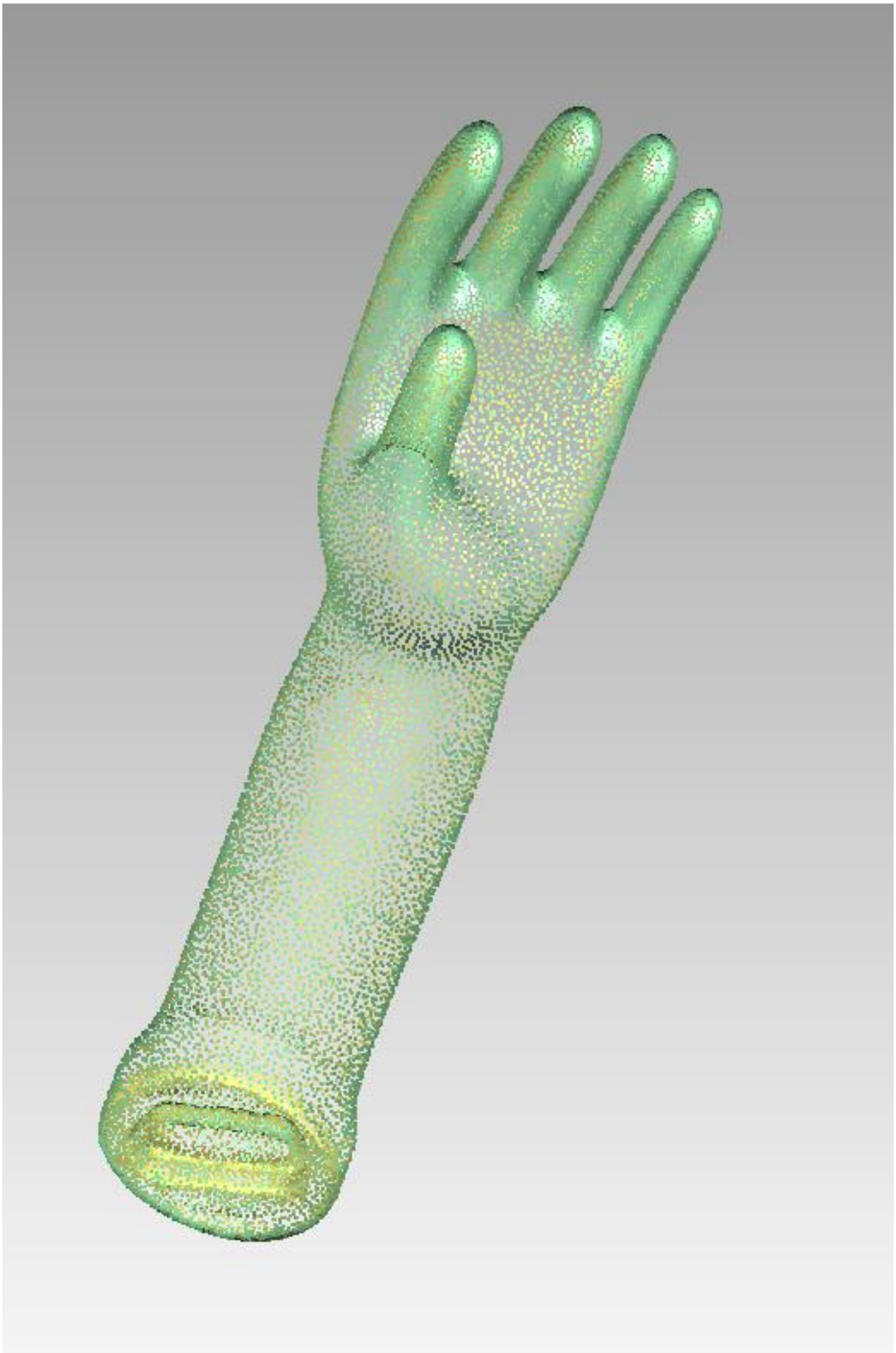
The traditional mold crafting is fast losing ground in the Industry 4.0 Era in shaping the former. The 3D technology accompanied by digitized scanning, mapping and editing capabilities provide excellent advancement in proto-tying the master-mold with excellent dimensional precision beyond imagination.

Our ceramic technology know-how in treating the former surface entails us to develop the optimum surface for the glove production. We are able to define most appropriate surface suitable for specific gloves productions.

The prospect of developing new former as dictated by the gloves design is limited only by the imaginations of the end users and designers. The possibility of ceramic former proto-type printed by three (3) dimensional printer and sent for instant laboratory dipping for real time evaluation and enhancement is a reality. This is a solid platform to facilitate the dynamics advancement of glove and former design in times to come.

SUMMARY OF CONTENTS

1. THE MAKING OF A FORMER



a) Overview: What goes into the former?

- It is fundamentally a mixture of Clay, Flux, Kaolin, Quartz (silica), Feldspar (which is a naturally occurring mineral), Grogs & Fine Aluminium powders in various particle sizes to form a ceramic mass by the sintering process.

- The above minerals and metals are further categorized by their intrinsic characteristics as follows and are further shown in the succeeding pages (Exhibit 1, 2, 3):

    - Bulk Density,
    - Plasticity,
    - Particle Size,
    - Loss of Ignition,
    - Whiteness,
    - Viscosity,
    - Water Absorption,
    - Chemical~ Alumina (Al_2O_3), Silica content (SiO_2),
    - Thermal Stability,
    - Modulus of Rupture.

b) Key attributes of former for different glove making applications.

- Such categorization is to satisfy the different requirements of various glove making processes:

    i) Examination/Surgical Glove Former:
    - Good alkaline resistivity especially powder free glove with high pH & anionic latex.
    - Good thermal stability due to high speed dipping (High Mullite content).
    - Thermal stability.

    ii) Household Glove Former:
    - Good viscosity in clay for distinctive/sharp pattern.
    - Finer Particle Size Distribution for high resolution of pattern on the former surface.

    iii) Industrial Glove Former:
    As required for bigger size formers;
    - High modulus of rupture (mpa).
    - High strength (mpa).
    - High Linear reheating change (%/hr).

- In short, it is a ceramic base that produced the above shapes to be dipped into the following latex & polymers;
    - Natural Rubber.
    - Nitrile.
    - Chloroprene.
    - Neoprene.
    - Poly-Isoprene.

- It caters to “chained - butterfly” dipping lines, (Examination and Surgical gloves) and “batch” dipping lines for Household and Industrial gloves (insulated gloves, protective work gloves, supported gloves & etc.)

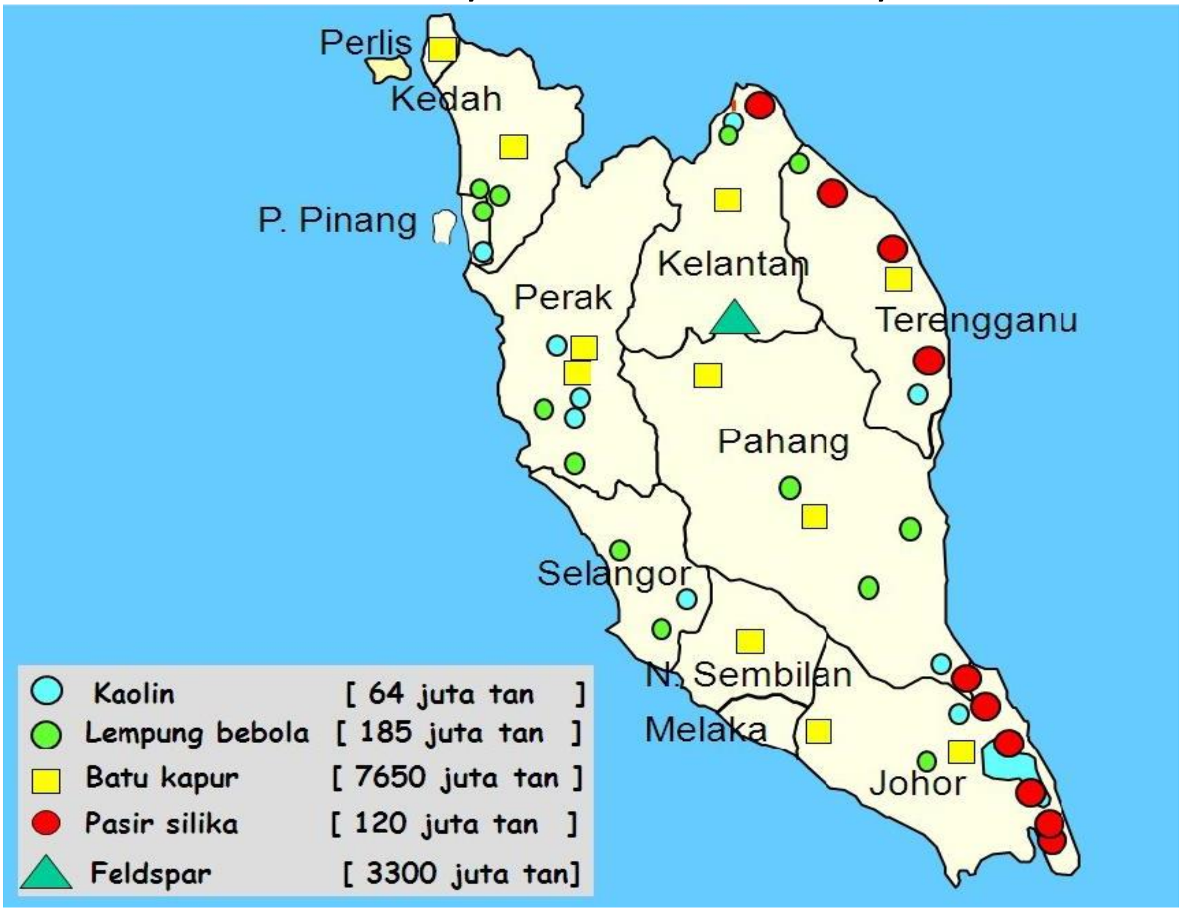
- Various polymers have its specific characteristics for different applications and are further explained in the “Treating” section which addresses the wetting, adhesion, gel- formation, contact angles, surface tension issues.

c) Availability of Mineral Resources: Clay and Kaolin are the essence of the ceramic formers and the principal supply sources are in China and the Asian countries, including Malaysia, as outlined below:

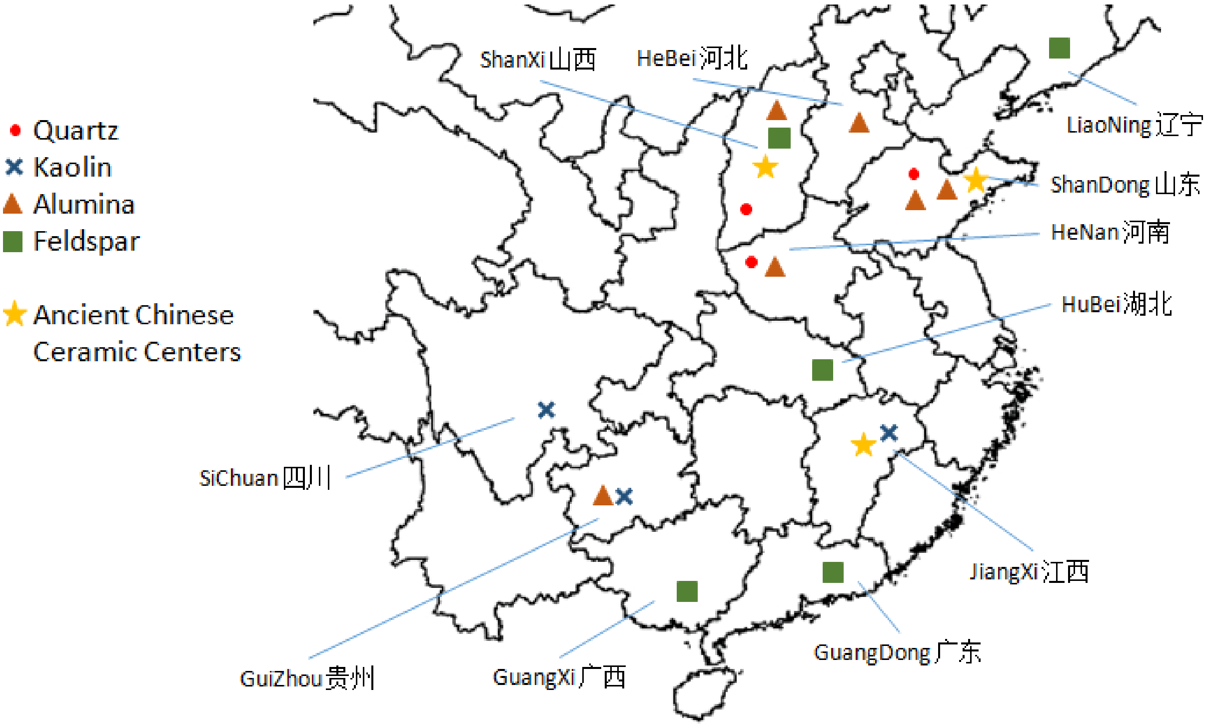
- The Perak State Authorities have excavated and exported Ball Clay and Kaolin from the Central zones of Trong, Perak, Cold Stream, Bidor, and Sungkai. (Exhibit 1)
- The Ranong, Sadao, and Lambang districts of Thailand.
- Belitung area of Indonesia.
- 11 Chinese provinces as next illustrated. (Exhibit 2)

The above supply sources will sustain a viable ceramic forming industry in the region as it has the variety of clay to form the “Body” and the required “Medicine Clay” for Specific Applications.

Exhibits 1: Availability of Mineral Resources in Malaysia



Exhibits 2: Availability of Mineral Resources in China



Exhibits 3: Typical Clay Sites in Perak

Picture 3.1: Clay site 1. Trong, Perak

Picture 3.2: Clay Site 2. Trong, Perak

Picture 3.3: White Kaolin Clay. Trong, Perak

Picture 3.4: Brown Kaolin Clay. Trong, Perak

Picture 3.5: Clay Sampling by GIC Personnel

Picture 3.6: Clay Sampling by GIC Personnel

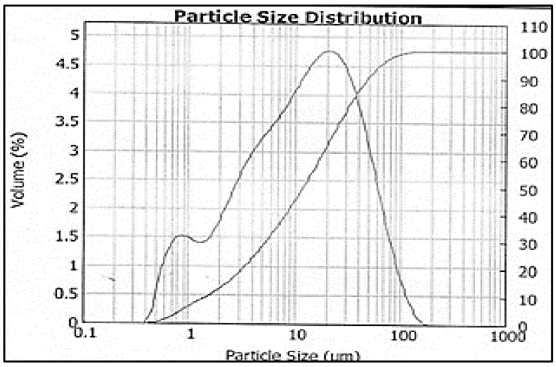
Picture 3.7: Preliminary Testing by GIC Personnel

Picture 3.8: Preliminary Testing by GIC Personnel

Exhibit 4: Typical Specification of Perak Clay

Sample I

PHYSICAL PROPERTIES	
Description	**Perak clay**
Fired Colour - Test pieces pre-fired at 1220°C (Hunter Lab colour, D65/10°)	7
Specific Gravity	2.58
Dry Bulk Density (g/cm^3)	1.76
Modulus of Rupture, MOR	
Average Green MOR (kg/cm^2)	14
Average Dry MOR (kg/cm^2)	19
Average Fired MOR (kg/cm^2)	296
Chemical Analysis (%)	
Silica as SiO_2	47.19
Aluminium as $A1_2O_3$	36.18
Titanium as TiO_2	0.75
Iron as Fe_2O_3	1.07
Sodium as Na_2O	0.03
Potassium as K_2O	1.64
Calcium as CaO	0.06
Magnesium as MgO	0.19
Loss on Ignition at 1025°C	12.2
L*	87.6
a*	1.5
b*	10.4



d(0.1) : 1.528 μm
d(0.5) : 12.263 μm
d(0.9) : 49.795 μm

Percentage below 2.00 μm : 12.80%
Percentage below 10.00 μm : 44.46%
Percentage below 20.00 μm : 64.62%
Percentage below 125.00 μm : 99.69%

Size (μm)	Vol Under %
0.300	0.00
0.414	0.00
0.570	0.95
0.670	2.16
0.787	3.66
0.924	5.26
1.085	6.82
1.274	8.32
1.496	9.80
1.756	11.37
2.000	12.80

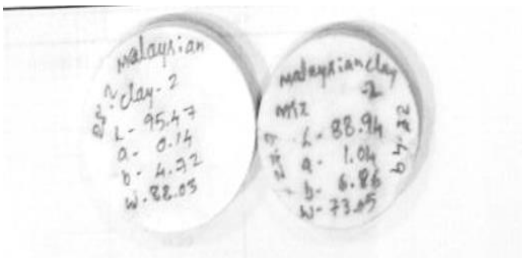
Size (μm)	Vol Under %
2.062	13.17
2.422	15.25
2.844	17.64
3.339	20.34
3.921	23.30
4.604	26.49
5.407	29.87
6.349	33.41
7.455	37.13
8.755	41.05
10.000	44.46

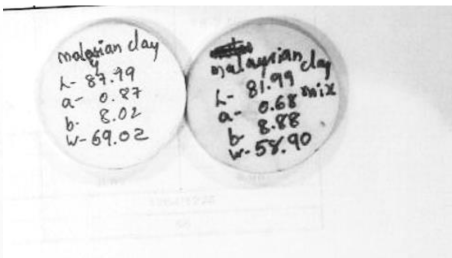
Size (μm)	Vol Under %
12.072	49.56
14.176	54.16
16.646	58.97
19.547	63.91
20.000	64.62
26.953	73.84
31.650	78.60
37.166	83.06
43.643	87.08
51.248	90.59
60.179	93.50

Size (μm)	Vol Under %
70.677	95.80
82.982	97.51
97.443	98.70
114.424	99.43
125.000	99.69
134.364	99.83
157.780	99.98
185.276	100.00
217.564	100.00
255.478	100.00
300.000	100.00

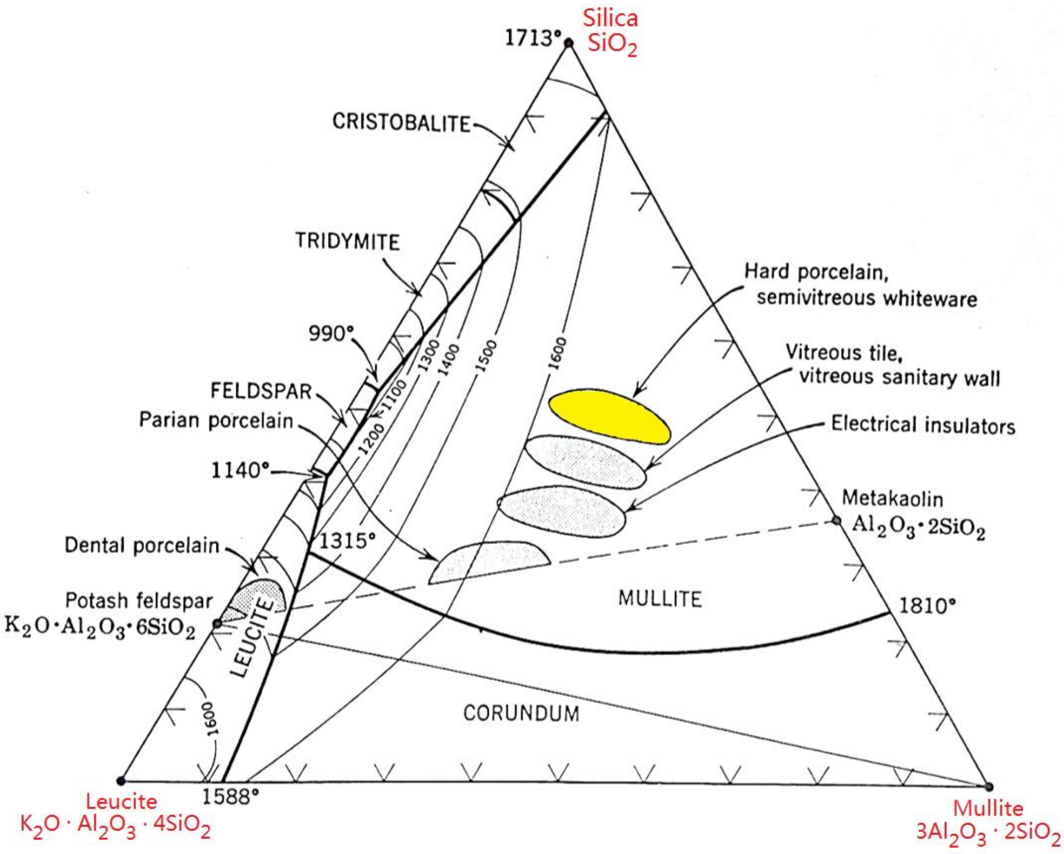
Sample II

PHYSICAL PROPERTIES		
Description	**Malaysian clay**	**Malaysian clay 40% + 60% Feldspar**
Moisture %	7	-
Water of Plasticity %	30	-
Dry MOR (Kg/cm2)	23.68	-
Shrinkage %	0.46	6.23
Loss on Ignition	5.93	3.1
Fired MOR (Kg/cm2)	63.1	-
Water Absorption %	12.95	3.38
L*	95.47	88.94
a*	0.14	1.04
b*	4.72	6.86
Temperature C	1204/1220	
Cycle min.	47	
CHEMICAL ANALYSIS		
SiO2%	69.8	
Al2O3%	20.8	
Fe2O3	0.25	
CaO %	0.35	
MgO%	0.28	
Na2O%	0.97	
K2O%	0.26	
Loss on Ignition %	6	
PHYSICAL PROPERTIES		
Description	TR-2	TR-2 40% + 60% Feldspar
Shrinkage %	8.77	6.52
Loss on Ignition %	12.78	5.29
Whiteness	69.02	58.9
L*	87.99	81.99
a*	0.87	0.68
b*	8.02	8.88
Temperature C	1204/1226	
Cycle min.	56	





Exhibits 5: Porcelain Phase Diagram



2. THE SHAPING OF A FORMER

d) Overview: ***Industrial 4.0*** in the Shaping Process;

- The "Shaping" process entails the making of the "mother mould" for the subsequent "Slip Casting" process.

- Technology advancement in Additive 3D Manufacturing allows the streamlining of the process through digitizing the copying, scanning and editing process in real time.

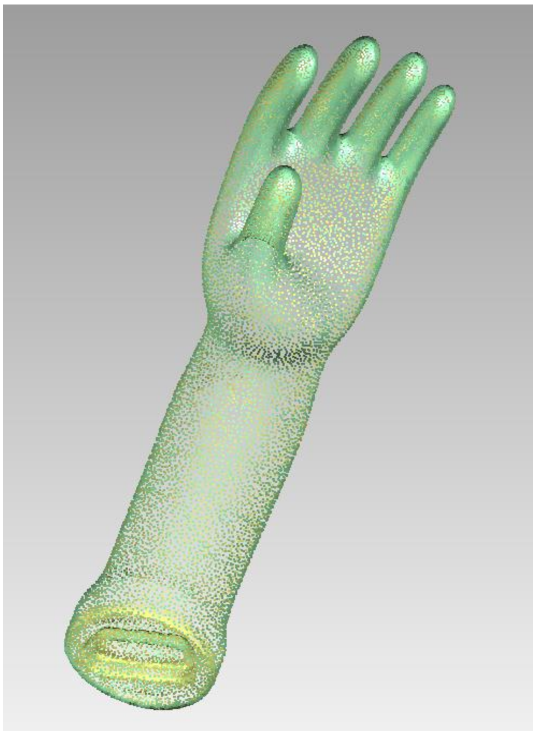
- Key components in "Shaping" process:

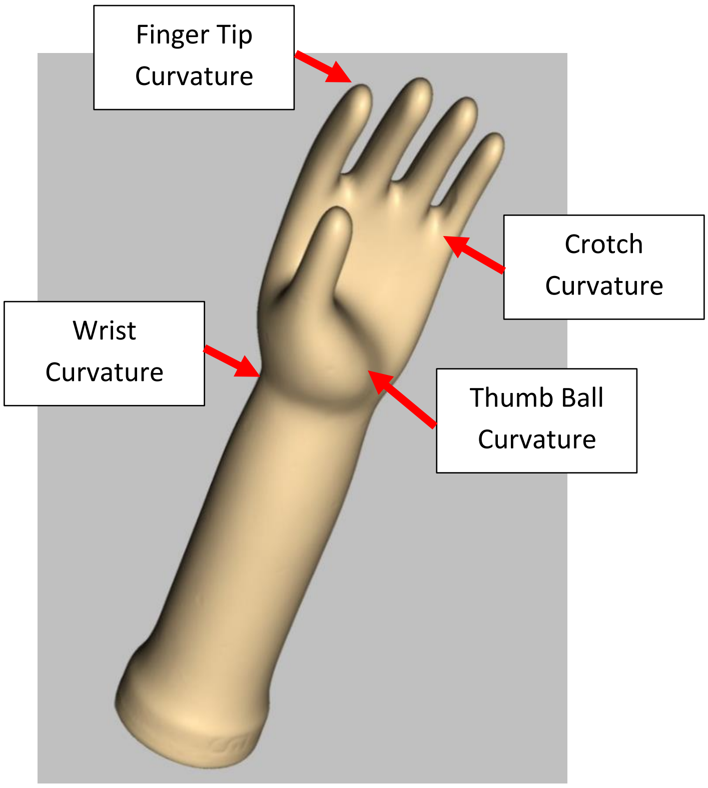
  The Static components:

  - Dimensional Specifications - Finger/Palm/Shank - Width, Diameter & Length.

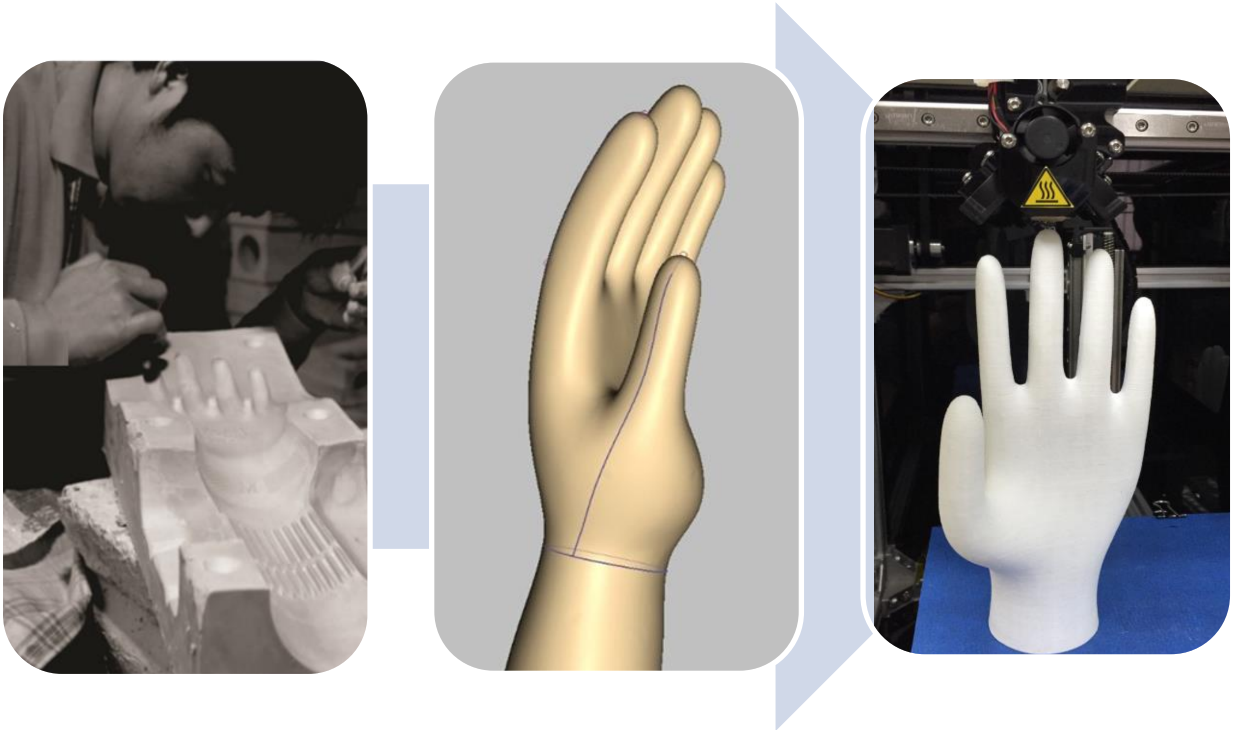
  The Dynamic components:

  - Profile/Curvature/Crotch profile - "Dynamics" due to the constraints of process control: Line Speed, Angle of Dipping & different wetting conditions.

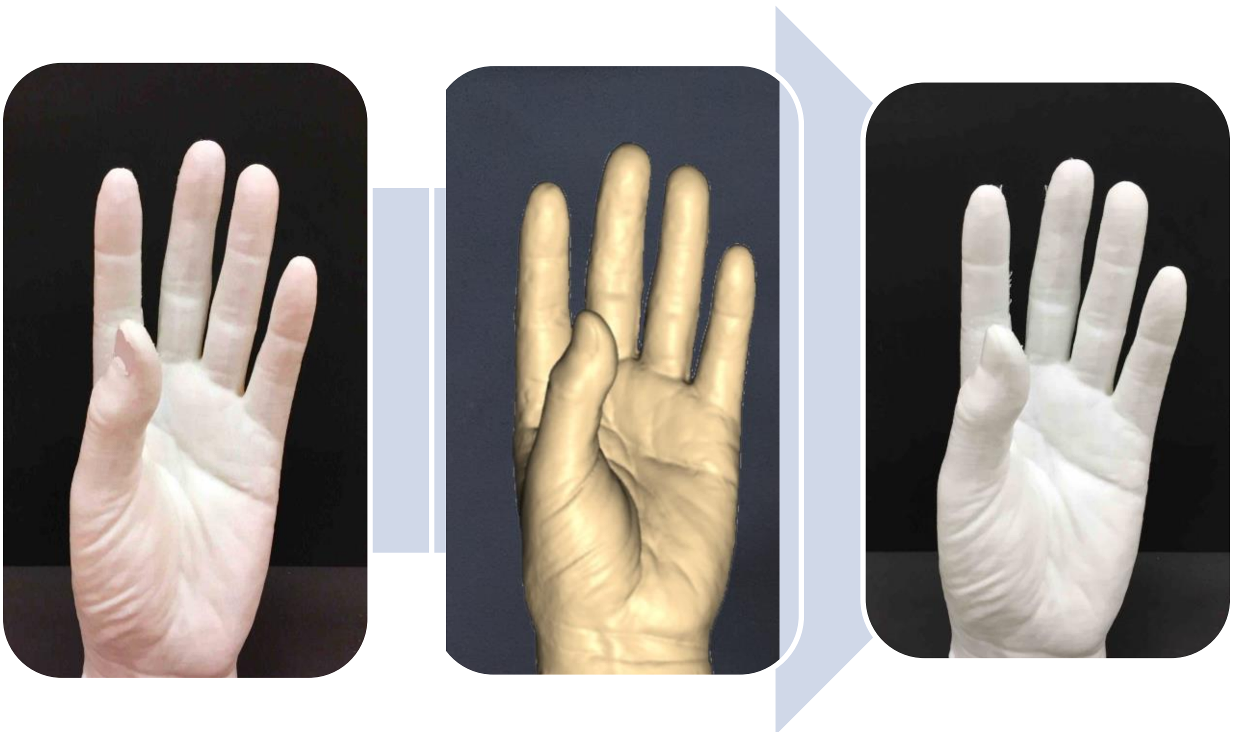




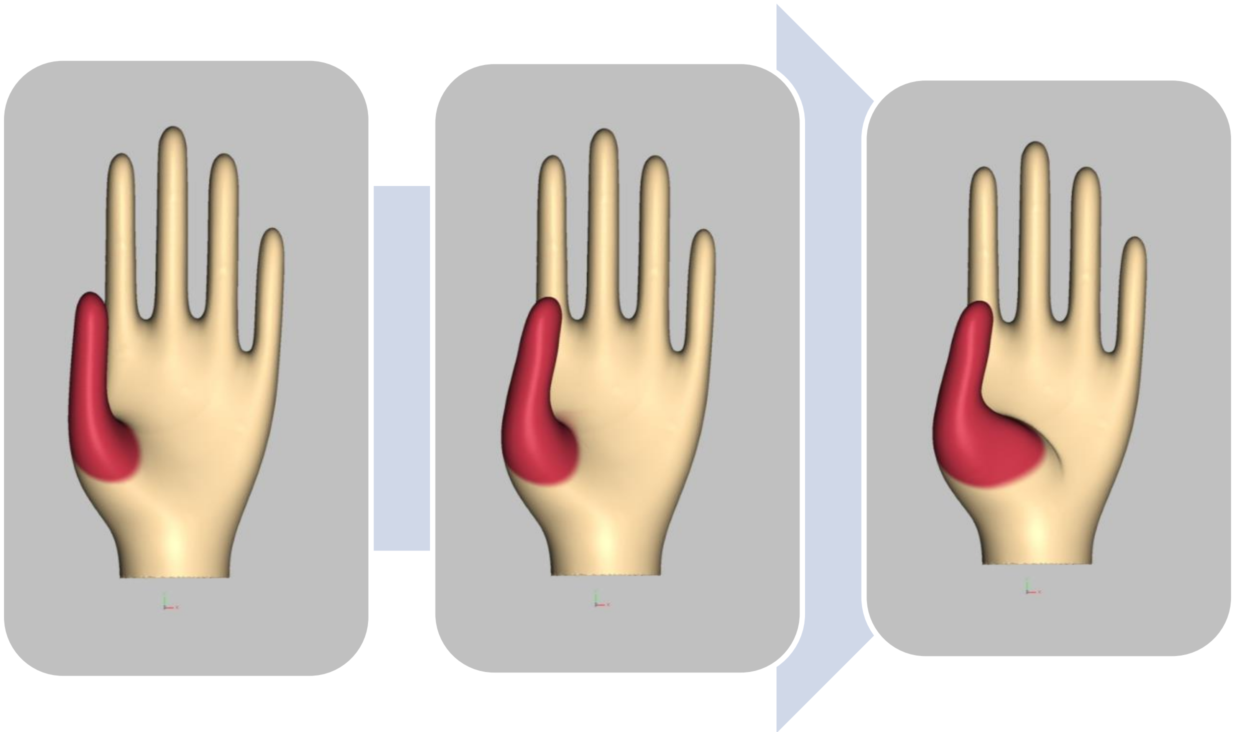
e) From Traditional to Digitization:

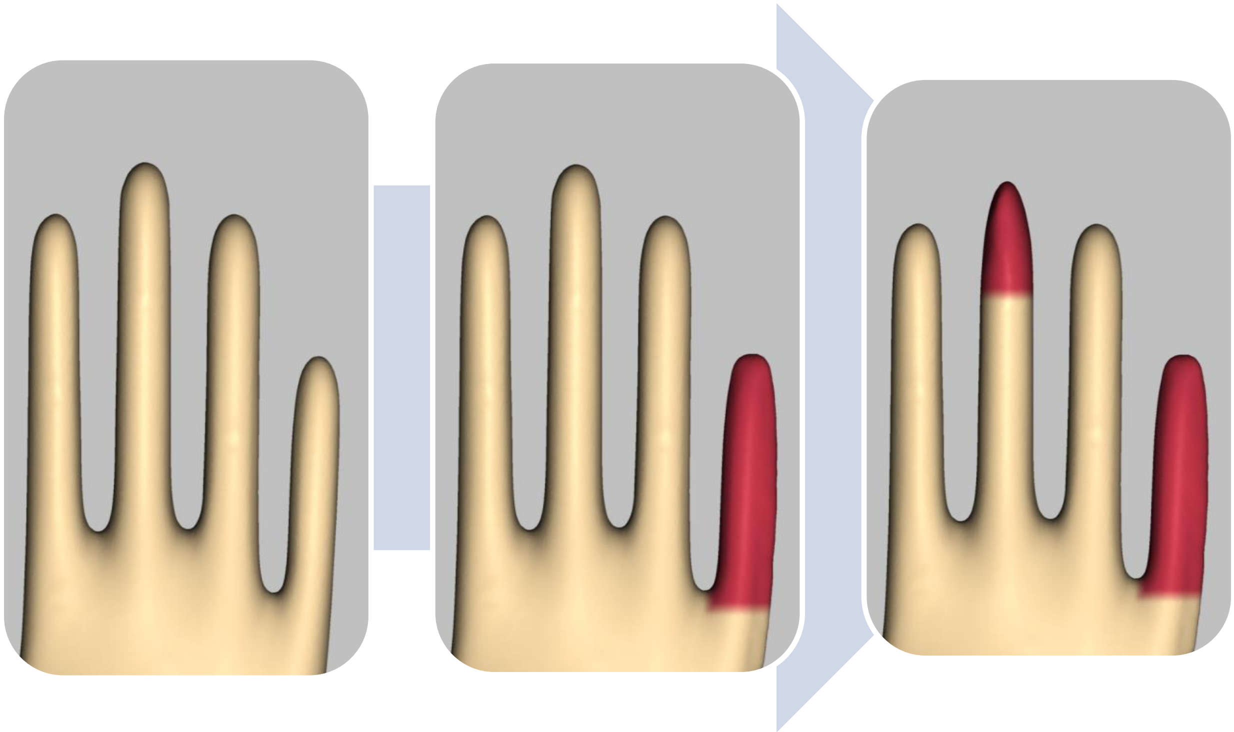


f) Bridging End User's and Production's Requirements:



- ❖ Real time replications from human model to digital model.





❖ Real time editing to facilitate ***End User's*** and ***Production's*** Requirement

g) KPI for the Digitization Process

Set free the traditional grey area

- Crotch curvature profile (pinhole, thin areas).
- Pattern (ruby grip, fish scale, hexagon)
- Finger tip profile.
- Wrist curvature.
- Thumb ball curvature.
- Rotational Radius of former.

Providing a Constance in Engineering Solution

- It speeds up the product launching time (180days - 30days).
- Effective prototype in real time (600mm length).
- Real time mapping and tracking for special design (patterns, characteristic, profile)
- Creating a customized platform to facilitate troubleshooting.

Objective Review on Process Operation

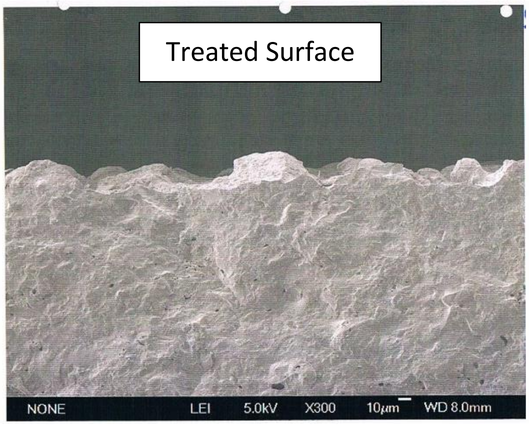
- Curing temperature.
- Leaching process.
- The gelling process.
- Chlorination.
- Priming.
- Polymer coating.

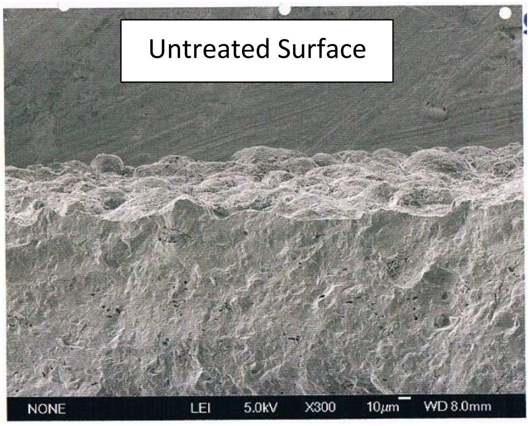
3. THE TREATING OF A FORMER

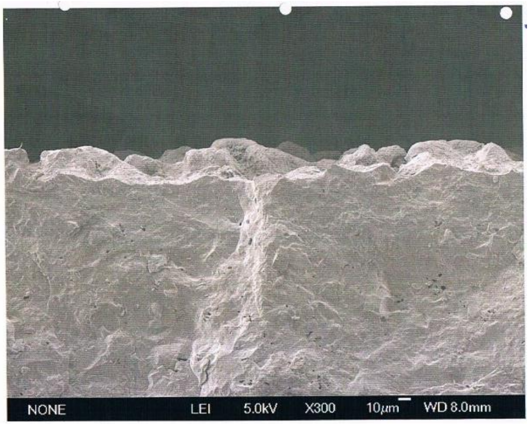
h) Overview: Characterization of Former Surface to enhancement Wettability for Specific Glove manufacturing.

- This is the final and most crucial step before we send the former to the glove manufacturer.

○ The solid surfaces are treated to facilitate the required "wetting phenomenon".







i) There are three (3) types of wetting phenomenon:

- Spreading Wetting- When a drop of ethanol falls on a clean glass surface, it spreads immediately and forms a thin layer on the surface.

  In this case, the ethanol is said to wet the glass surface by "Spreading".

- Immersional Wetting- When the lower end of a clean glass capillary is put into the water, water rises along the inside wall of the capillary.

  In this case the water is said to wet the inside wall of the capillary by "Immersion".

- Adhesional Wetting- When a drop of mercury is put on the glass plate, it contacts the glass surface forming a small flat bottom.

  In this case, the surface contacting with the part of the drop in such state is said to get wet by "Adhesion".

o The "wetting" phenomenon is created in respective treatment of the former surface applied to designated scenario as follow:

- High volume, high speed chained dipping line for Examination and Surgical glove (NBR, NR, PI, CR).

- Batch line dipping for specific shapes of household and industrial gloves (NBR, NR).

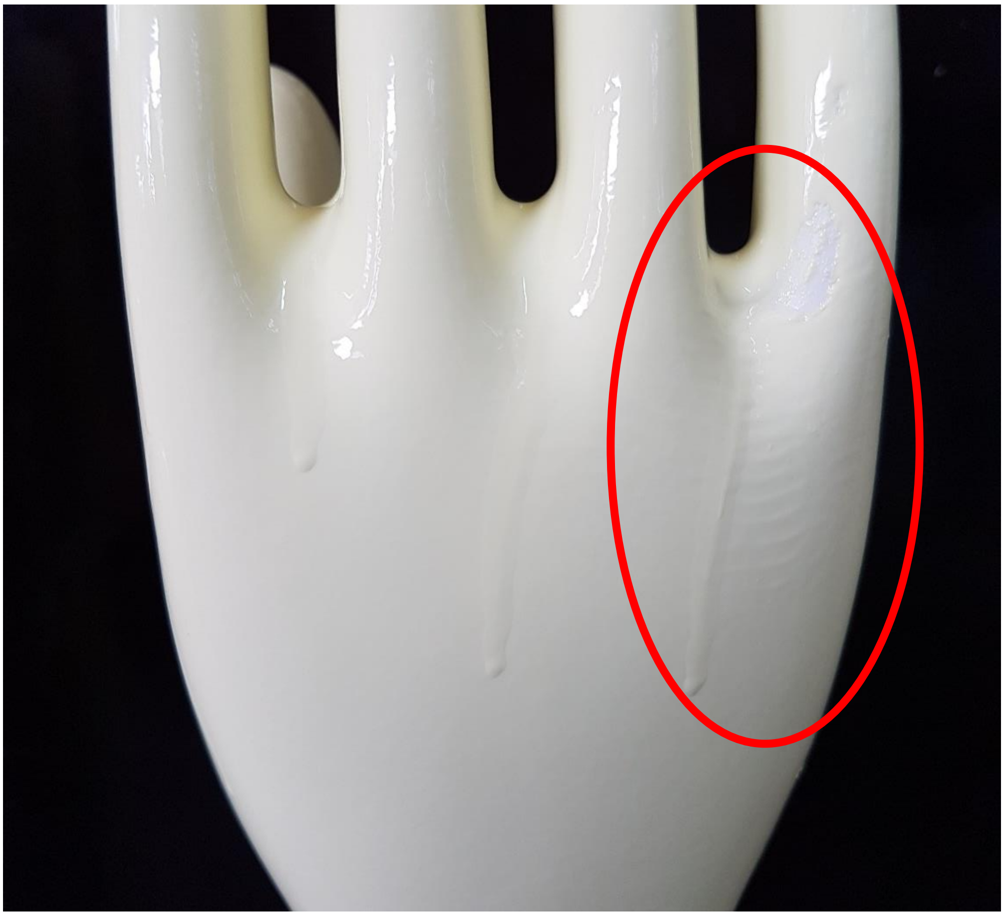
- Specialty gloves for clean room glove, electrical glove, supported glove (NR, NBR, CR, Neoprene, Polyisoprene).

j) A case study of a typical surface "treating" for NBR Surgical glove is given and outlined below:

Note 1: A similar case for the natural rubber, poly- Isoprene, and chloroprene could be easily presented given more time.

Note 2: The above dipping was done in the laboratory. The limitations of a laboratory dipped scenario as compared to a line dipped result is duly noted.

Exhibit 6: Dipping process of NBR of Surgical former with untreated surface;



Uneven wetting with obvious flow mark.

Exhibit 7: Dipping process of NBR of Surgical former with “treated” surface;

Even wetting with no obvious flow mark.

Exhibit 8: “Treated” Vs “Untreated” surface in Chained Dipping Condition.

Glove weight and thickness comparison
(Real Time Data extracted from trial - NBR EXAM GLOVE)

				Thickness		
Former	Weight (g)	Length (mm)	Palm width (mm)	Cuff	Palm	Finger
Treated GIC Surface Former	**3.1**	**244**	**97**	**0.048**	**0.057**	**0.085**
CONTROL	**2.9**	**244**	**98**	**0.043**	**0.053**	**0.085**

“Treated surface” produce higher glove weight due to better wetting of latex.

This is a special scenario with objective: ***To produce similar glove thickness with lower concentration of compound for possible cost savings.***

4. Q&A

Related Topics of Interest

k) Insulation Optimization Using Ceramic Technology (https://www.gloveformer.my/furnace)

l) Recycling of Ceramic Materials (https://www.gloveformer.my/recycling)

m) Tracking of former using RFID (http://www.gloveformer.my/RFID)