

DMLS(Direct Metal Laser Sintering) **공정을 이용한 기능성 신발부품** **쾌속금형 제작기술**

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홍경호 (주)한국프라마스)

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About framas Global

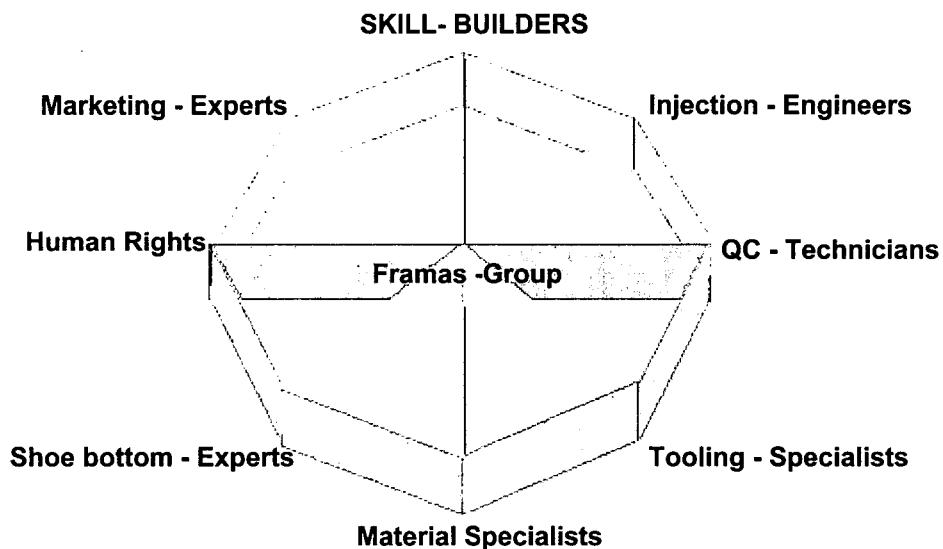
Framas Global has created his own new perspectives

Framas general news:

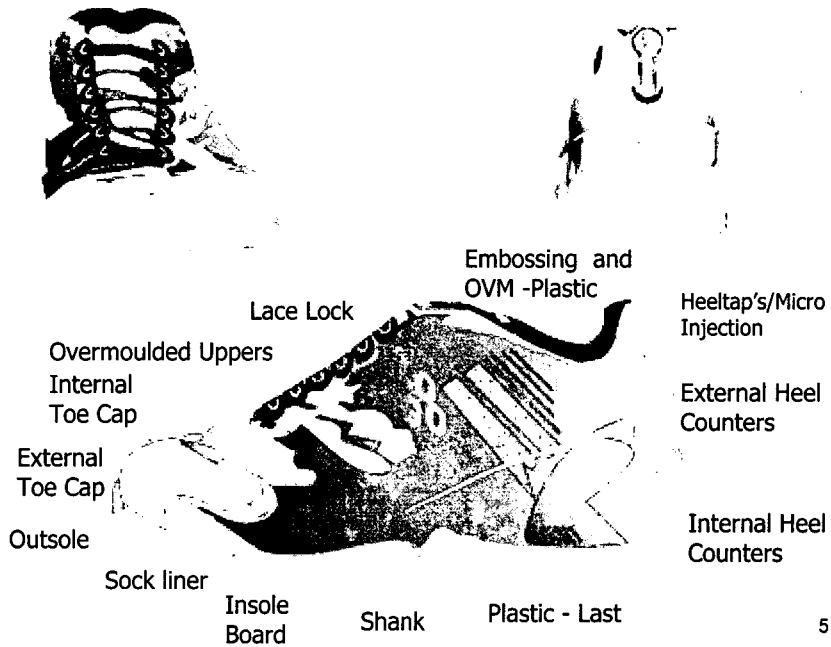
- *Asia Wide Production Facilities*
- *global thinking*
- *scientific molding Technologies (smT)*
- *built in "advanced Innovation Technology (aiT)*
- *global process and procedure sharing*
- *global material sourcing*
- *global ideas and innovation / brainstorming*
- *leading worldwide manufacturer in our operating field*

framas is an affiliated of worldwide trading

Who are in fram



framras Performance & Capabilities



Framas Global

Country	Established	Employee	Machine
Germany	1948	120	61
Korea	1988	180	56
Busan R&D	1996	35	6
Indonesia	1993	480	82
China (D.G)	1998	560	105
China (F.Z)	2002	120	30
Vietnam	2000	316	44
Total		1,804	384

Why RT for Prototype Injection Mold?

a. Advantage ;

- Shorten Mold Lead-time (depend on Design)
- Save Mold Cost (in case of small & complicated mold)
- Compatibility with other processes
→ parts can be milled, drilled, welded, EDM, etching, etc....
- Very high geometric flexibility
→ e.g. free-forms, deep slots, undercut, etc...
- High productivity and Low personnel costs
- Easy to polish the surface

b. Disadvantage ;

- Limitation of core size (Max. 250 x 250 mm with current Machine)
- One side surface which is met with support is very rough & hard to trimming : **In-Lay core**
- Need to improve the parting surface in order to fit tightly in assembly
- Owing to DirectTool (without graphite model for EDM), it's hard to modify RT mold if it's essential to changes once completed mold.

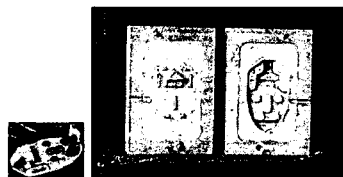
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Rapid Tooling Methods

Two Tooling approaches:

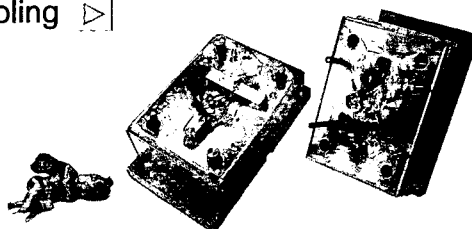
1. Indirect approach: Soft tooling ▷|

- Epoxy
- Series of 10 - 500 parts



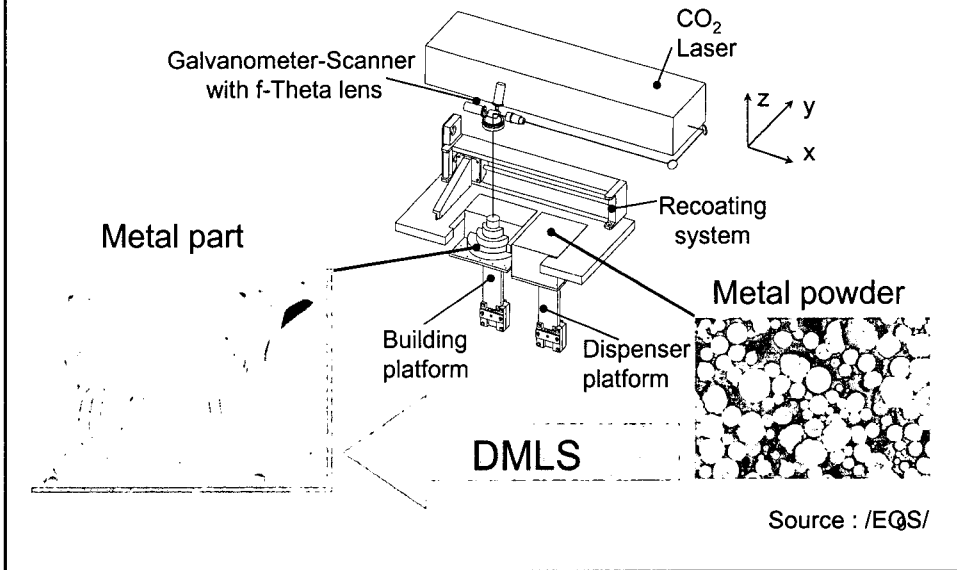
2. Direct approach: Hard tooling ▷|

- Series up to 10.000 parts

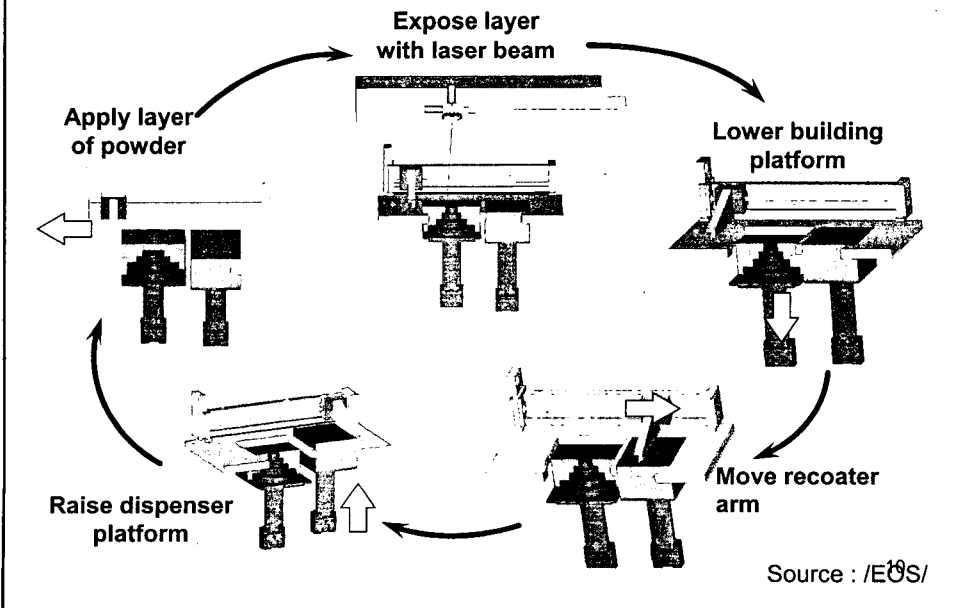


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SLS(Selective Laser Sintering) – Working Principle

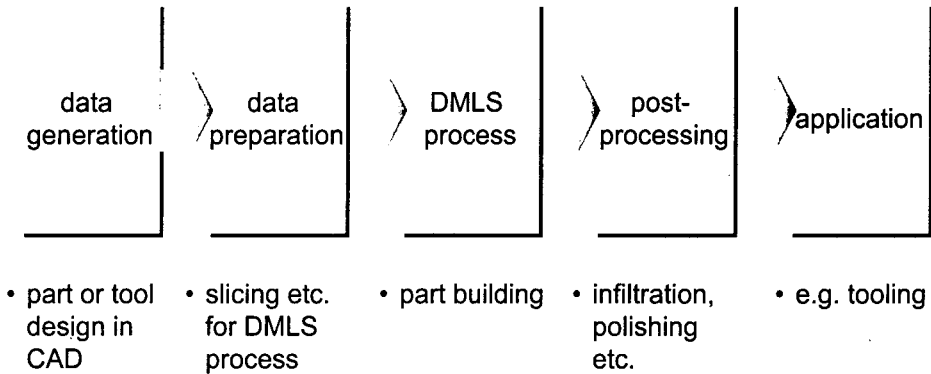


Operating Sequence



SLS Rapid Tooling

Process Chain

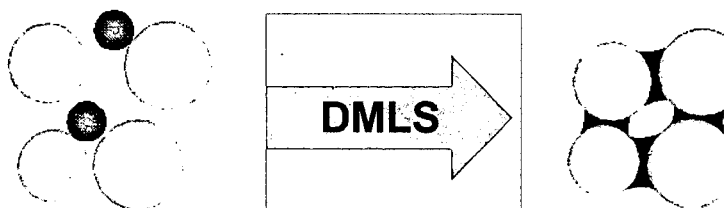


Source : /EÖS/

DMLS(Direct Metal Laser Sintering) - Process

Principle

- Laser-induced liquid-phase sintering
 - › mixture of low- and high-melting point (m.p.) metal powders
 - › high m.p. component provides strong matrix
 - › low m.p. component is melted by laser energy and binds matrix
 - › expansion reaction compensates for sintering shrinkage
 - › solidification results in stable metal structure

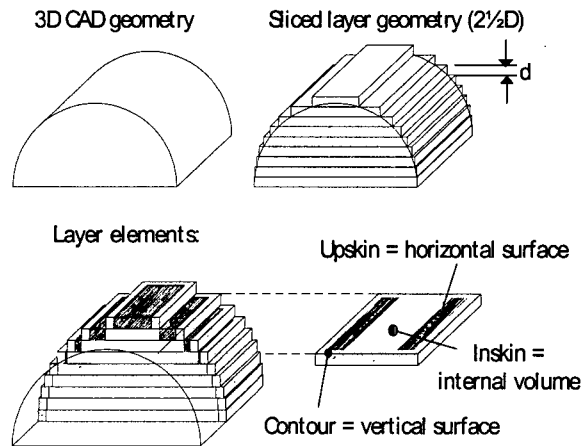


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DMLS- Process

Layer Elements

- Layers contain only horizontal and vertical surfaces



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DMLS Materials

Summary of Important Parameters

	DM 20	DS 20
Typical achievable part accuracy (μm)	± 50	± 50
Minimum wall thickness (mm)	0.6	0.7
Remaining porosity (minimum, %)	8	2
Tensile strength (MPa)	400	600
Hardness (HB)	110	220
Surface roughness (μm) without post-processing	R _a 9 R _z 40 - 50	R _a 10 R _z 50
Surface roughness (μm) after shot-peening	R _a 3 R _z 15	R _a 4 R _z 15
Coefficient of thermal expansion ($10^{-6}/\text{K}$)	18	9
Thermal conductivity @ 25°C (W/mK)	25	13
Maximum operating temperature (°C)	400	800

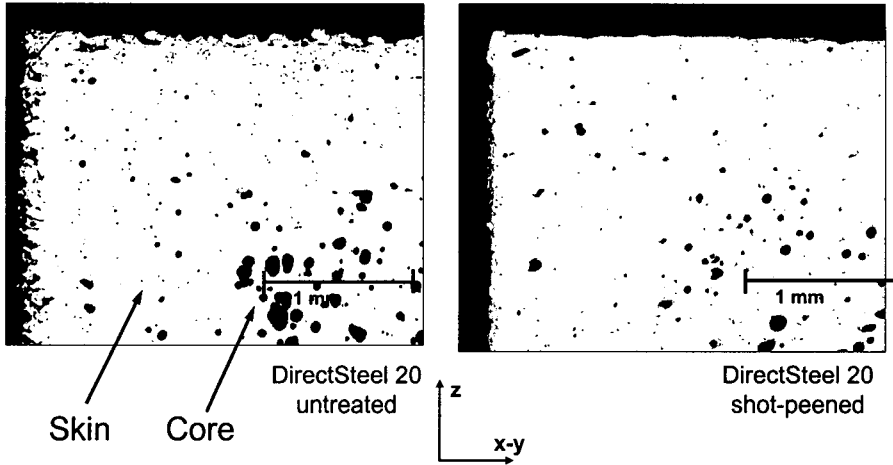
DM20 : bronze-based metal powder (Max. particle size=20 μm)

DS20 : iron-based metal powder

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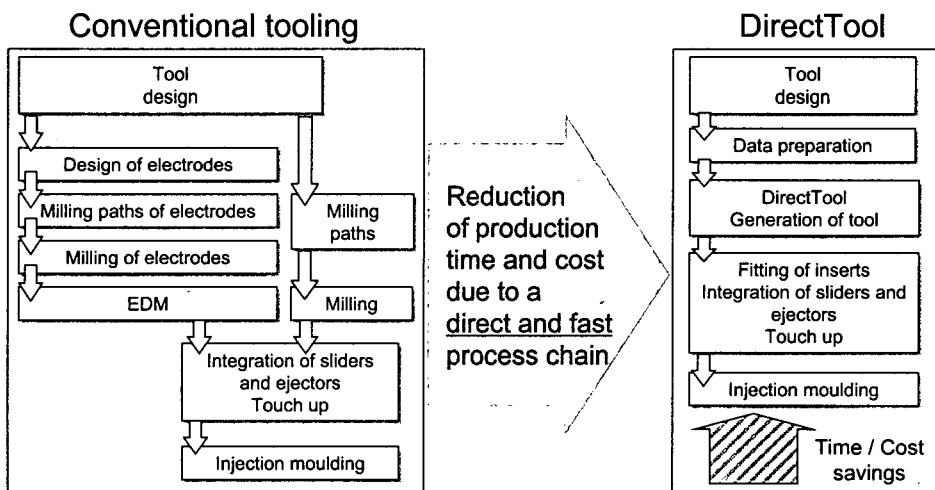
Micro Shot Peening

Test Results (DirectSteel)



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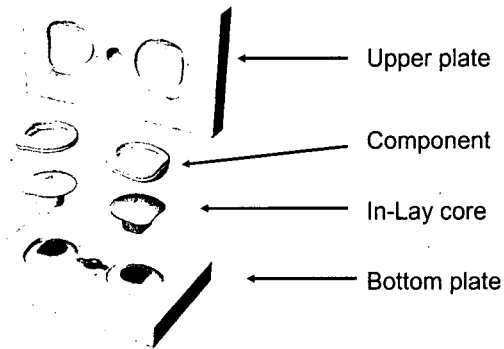
DirectTool Process Chain



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Overall RT Mold construction

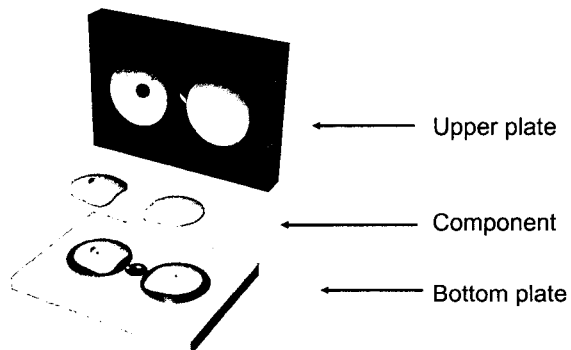
- **Test Components**
 - Sealing – Basf C60A
- **Mold Construction**
 - Moveable (In-Lay) Core Construction



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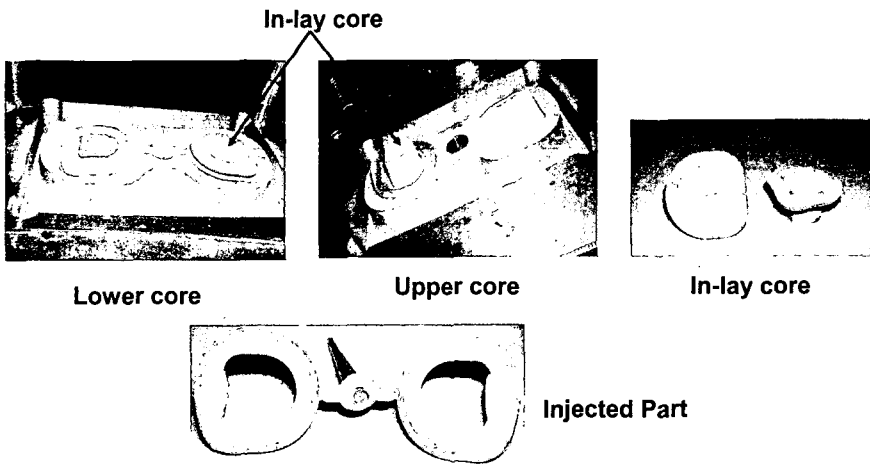
Overall RT Mold construction

- **Test Components**
 - Top & Bottom plate – EMS L20LF/ L20G
- **Mold Construction**
 - Standard 2 cavities injection mold



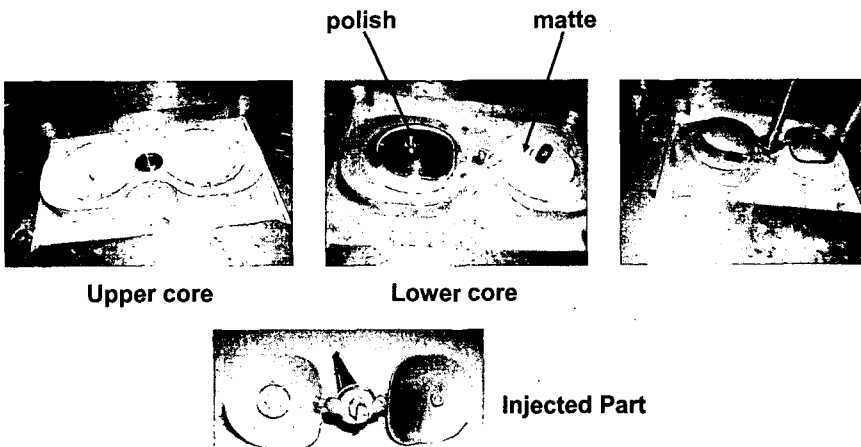
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Sealing RT Mold



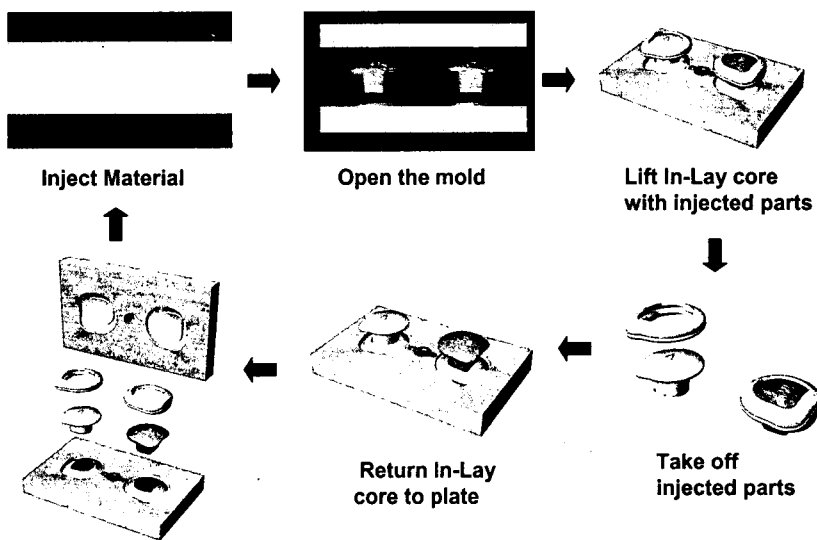
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Top/ Bottom plate RT Mold



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Overall RT Mold - Injection Process



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Overall RT mold Trial details

a. RT mold Quantity : Total 2 sets (5 days)

- Sealing Mold - 1 set
 - ✓ Upper core : 1 ea
 - ✓ bottom core : 1 ea
 - ✓ In-Lay core : 2 ea (Thickness : 3mm & 2mm)

- Top & Bottom plate Mold – 1set
 - ✓ Upper core : 1 ea
 - ✓ Bottom core : 1 ea

b. Mold Lead-time ; 8 - 10 days (in general with normal shape)

c. Mold Cost ; Total : US\$ 4,400

- ❖ Sealing Mold : US\$ 2,500
- ❖ Top & Bottom plate Mold : US\$ 1,900

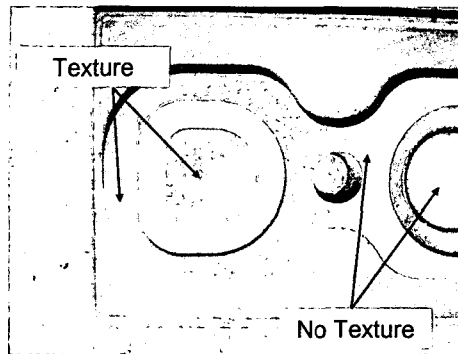
*** The cost are excluded Mold base & Assembly cost.

*** RT cost should be different with core volume and sizes.

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Evaluating – texture/ coating/ welding/ durability ...

a. Texture

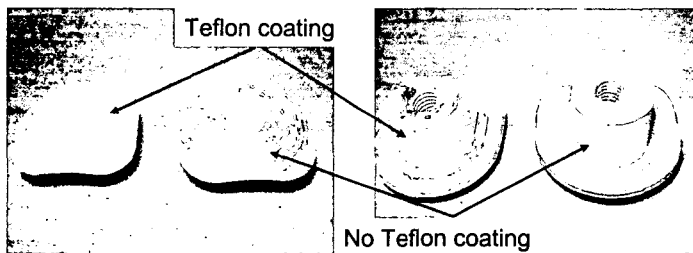


- In general, Texture is possible.
- Need the customized special textures process for RT.

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Evaluating – texture/ coating/ welding/ durability ...

b. Teflon Coating

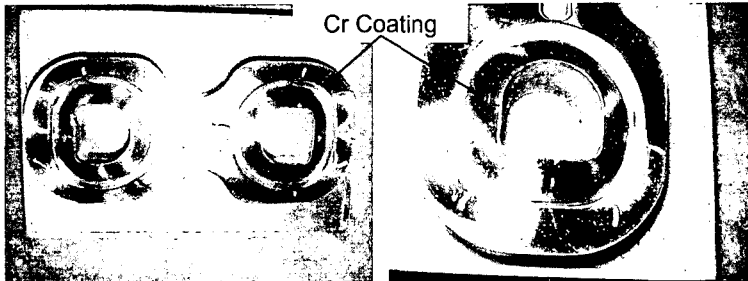


- In general, Teflon Coating is possible.
- And there are no distortion after coating.
- For reference, the RT material melting point is 400°C and the Teflon need 280° - 350°C in coating process.

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Evaluating – texture/ coating/ welding/ durability ...

c. Chromium Coating for polished surface

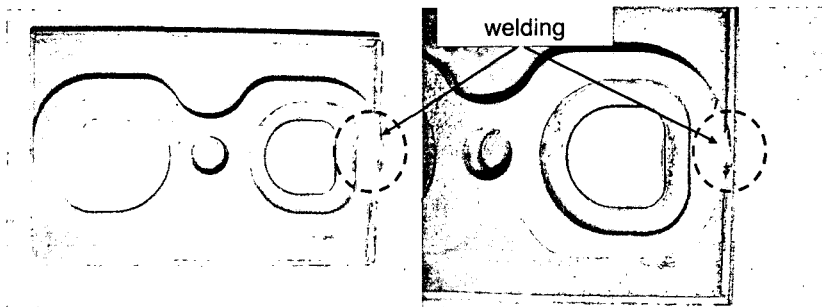


➤ In general, there are no issues.

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Evaluating – texture/ coating/ welding/ durability ...

d. Welding

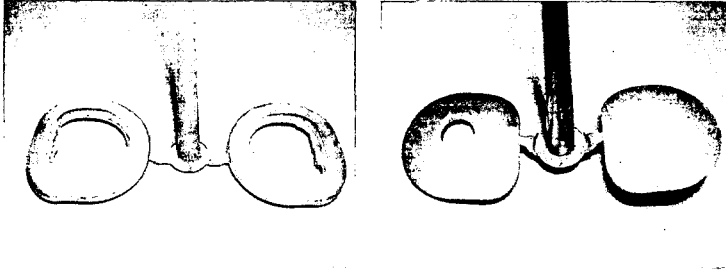


➤ In general, there are no issues.

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Evaluating – texture/ coating/ welding/ durability ...

e. Durability



- In general, there are no issues.
- So far frames have produced about 500 – 600 pcs without any distortion.
- and based on this data, we could expect 5,000 pcs as guideline from Maker

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Conclusions

1. Time & Cost saving potential exists (depends on design).

2. Evaluating Results :

- Texture is possible.
- Teflon costing is possible (without distortion).
- Chromium coating for polished surface is possible.
- Welding is possible.
- Durability ; 500-600 pcs without any distortion
(5,000 pcs are expected)

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