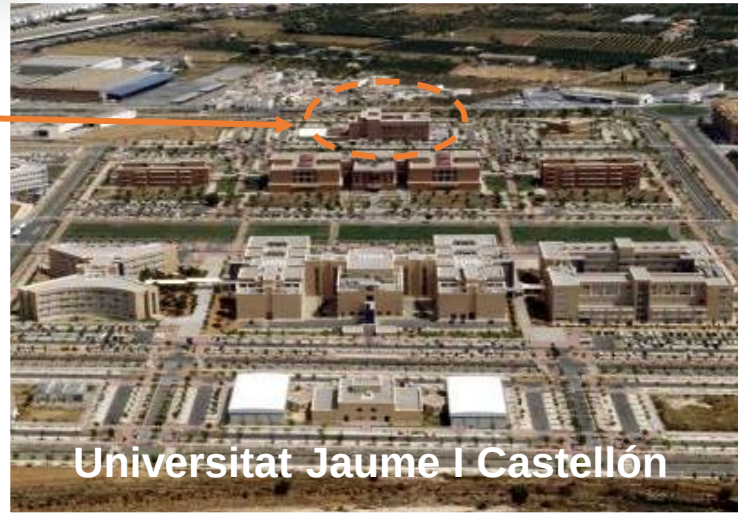
# CERAMIC PIECES PRINTED USING BINDER JETTING

CHARACTERIZATION OF MATERIALS

# CERAMIC CLUSTER OF CASTELLÓN AND ITC

Ceramic Tile Cluster




## CERAMIC TILE CLUSTER

- ✓ 180 Tile manufacturers
- ✓ 26 Glaze, Frit and Ink producers
- ✓ >30 Machinery producers
- ✓ 16 Raw Materials suppliers

>21,000 DIRECT JOBS
5,500 M €

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# WHAT SECTORS WE WORK IN

#Coatings #Plastics #Nanoparticles

#Habitat #Membranes #Machinery

#Energy #Chemical #Sanitaryware

#3DPrinting #Ceramictiles #Inkjet

#Environment #Glass #Refractories

#Constructionsystems #Petroleum derivates

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# CERAMICS & INDUSTRY

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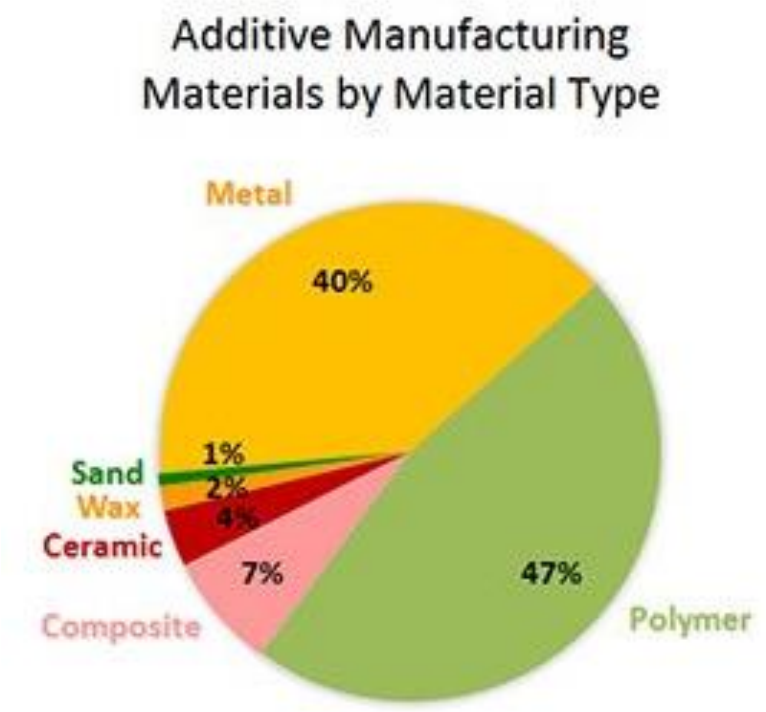
# AM & CERAMICS

The 3D printed ceramics market may not yet be as large as the polymer market, but it is one to watch. This market is expected to grow from a $20 million revenue opportunity in 2020 to more than $450 million by 2029, according to a report by SmarTech Analysis.




Font: Senvol Database

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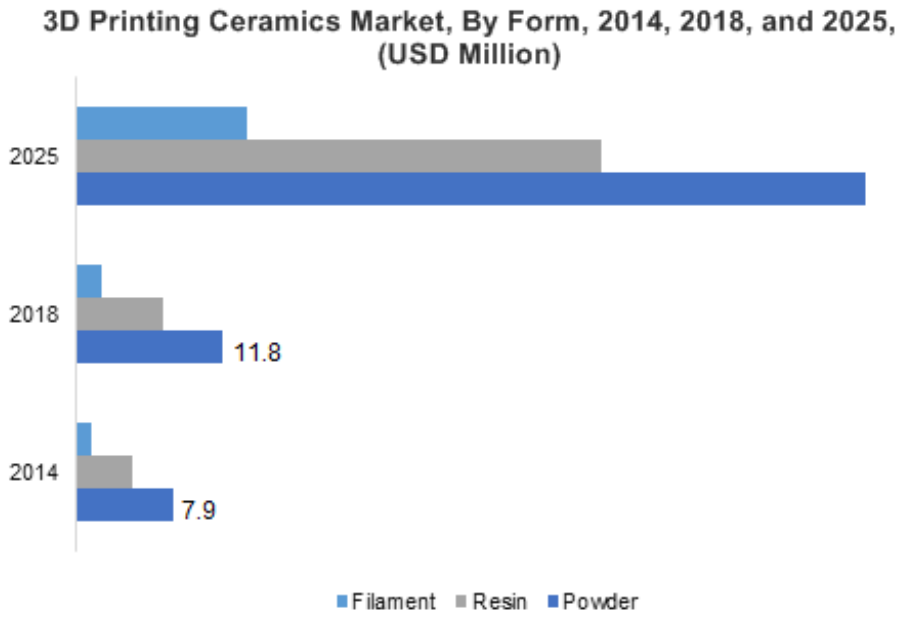
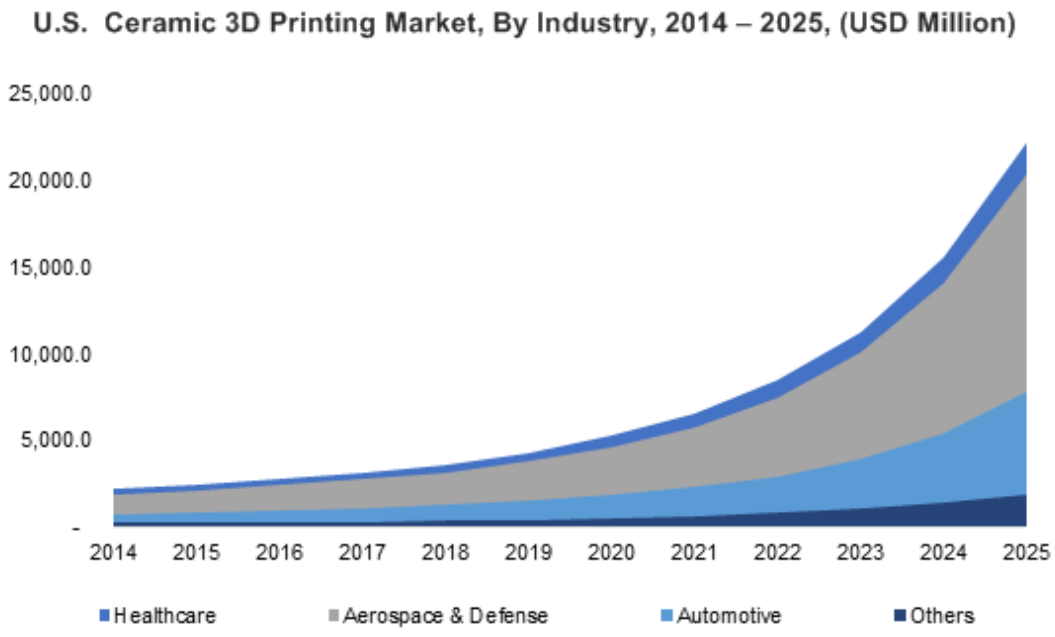
# AM & CERAMICS




Font: SmarTech




Font: Global Market Insights

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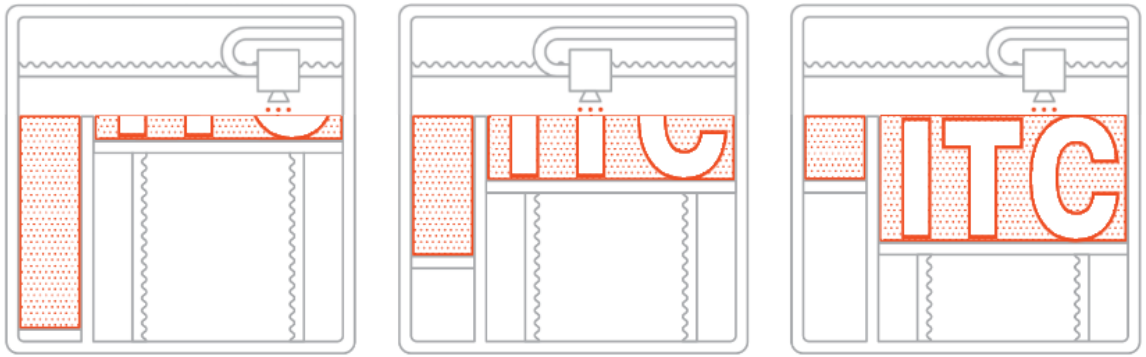
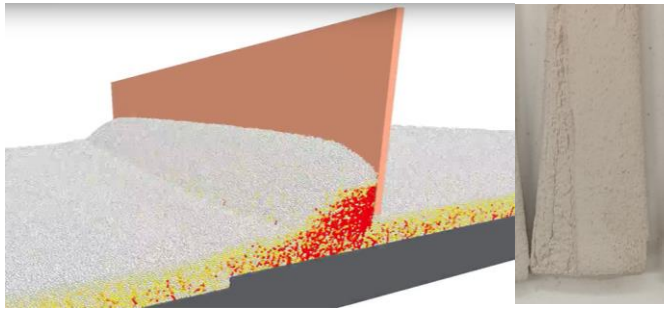
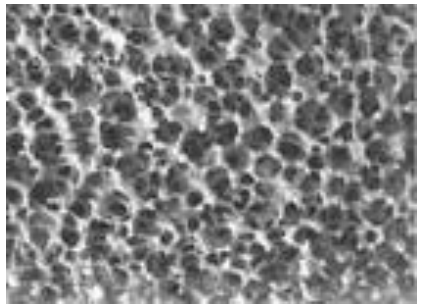
# BINDER JETTING



Distribution/Layer height

Brittleness in green



Porosity

Fast

No support structures

Scalability

Variety of materials

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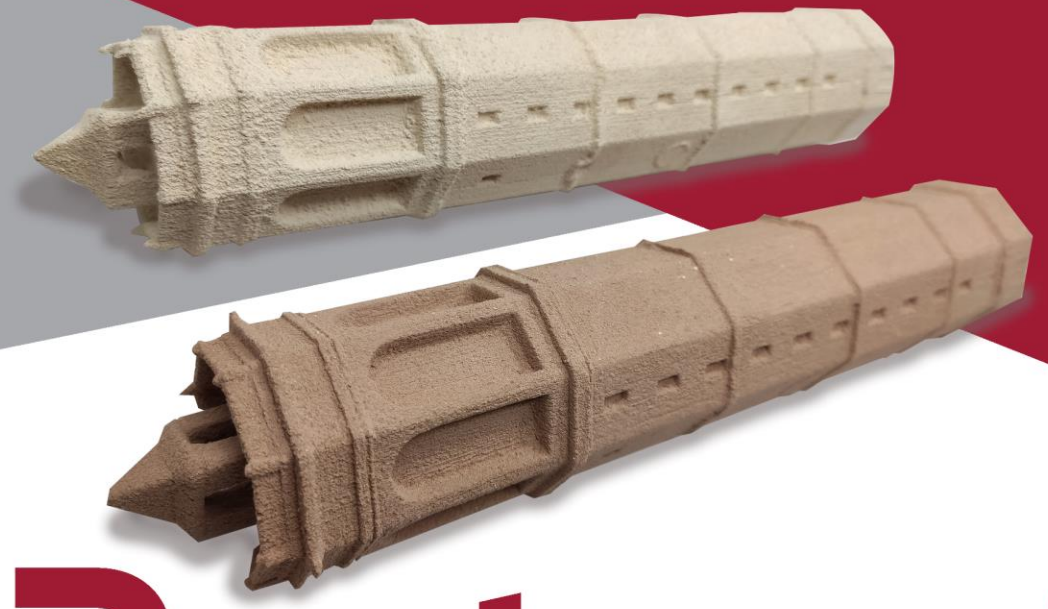
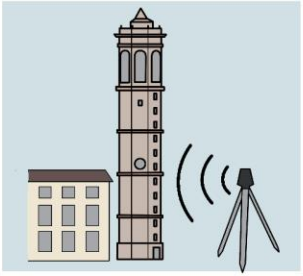
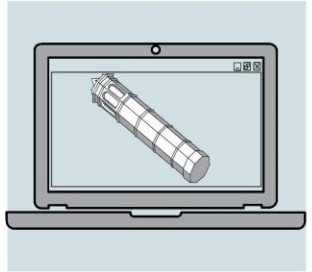
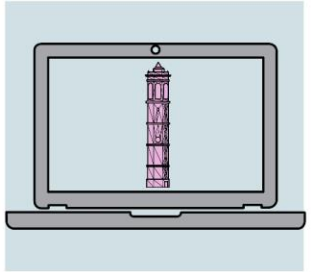
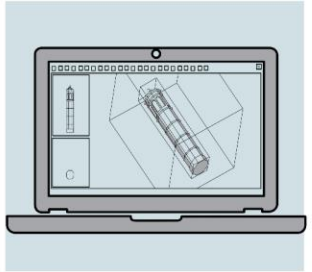
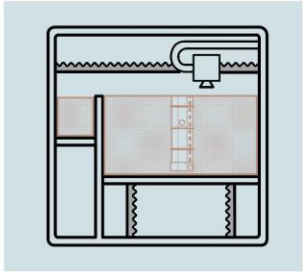
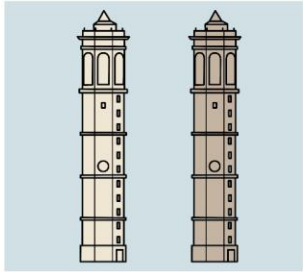


# 3D RestaurAM

www.3drestauram.es

GENERALITAT VALENCIANA

IVACE INSTITUTO VALENCIANO DE COMPETITIVIDAD EMPRESARIAL

AICE jtc UNIVERSITAT JAUME I

UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
*Una manera de hacer Europa*

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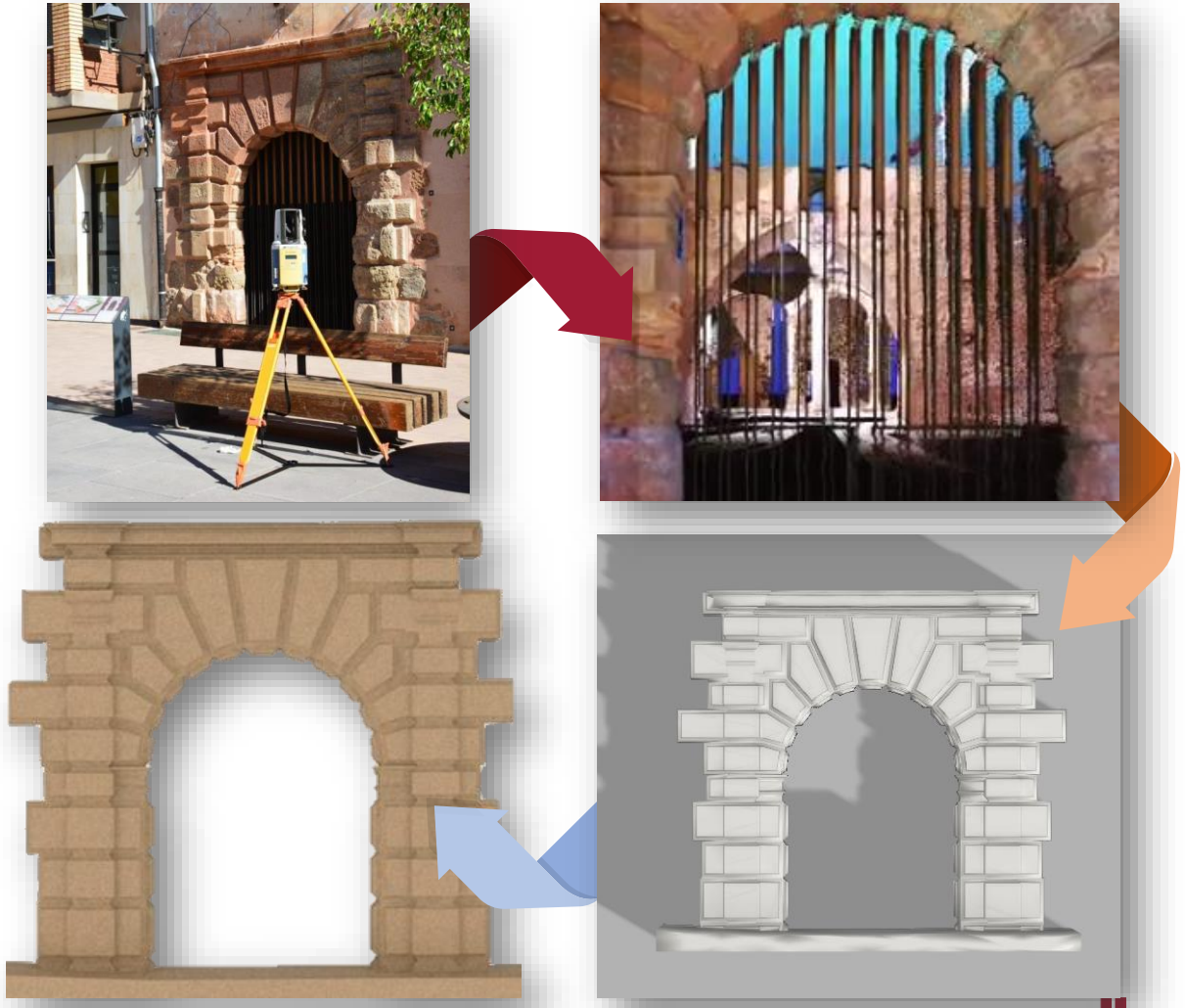
# 3DRESTAURAM



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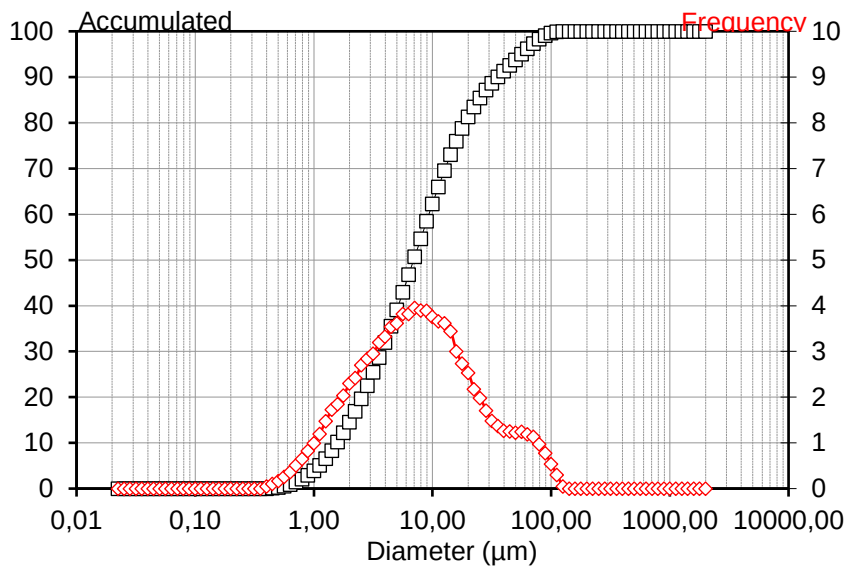
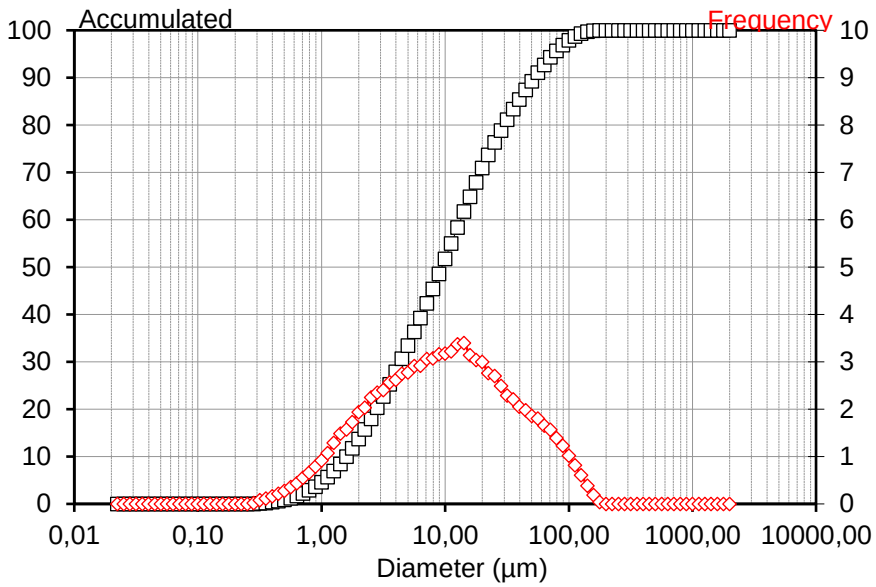
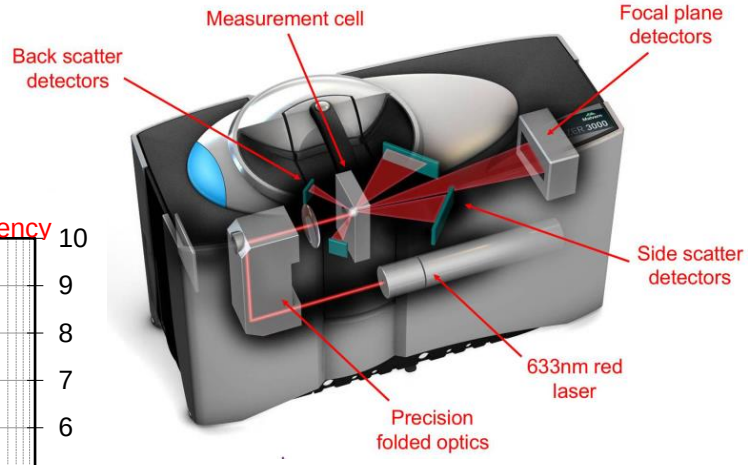
# STONEWARE CHARACTERIZATION




| | Interpolated diameter (µm) |
|---|---|
| d90 | 35,60 |
| d50 | 6,94 |
| d10 | 1,57 |




| | Interpolated diameter (µm) |
|---|---|
| d90 | 52,61 |
| d50 | 9,40 |
| d10 | 1,59 |

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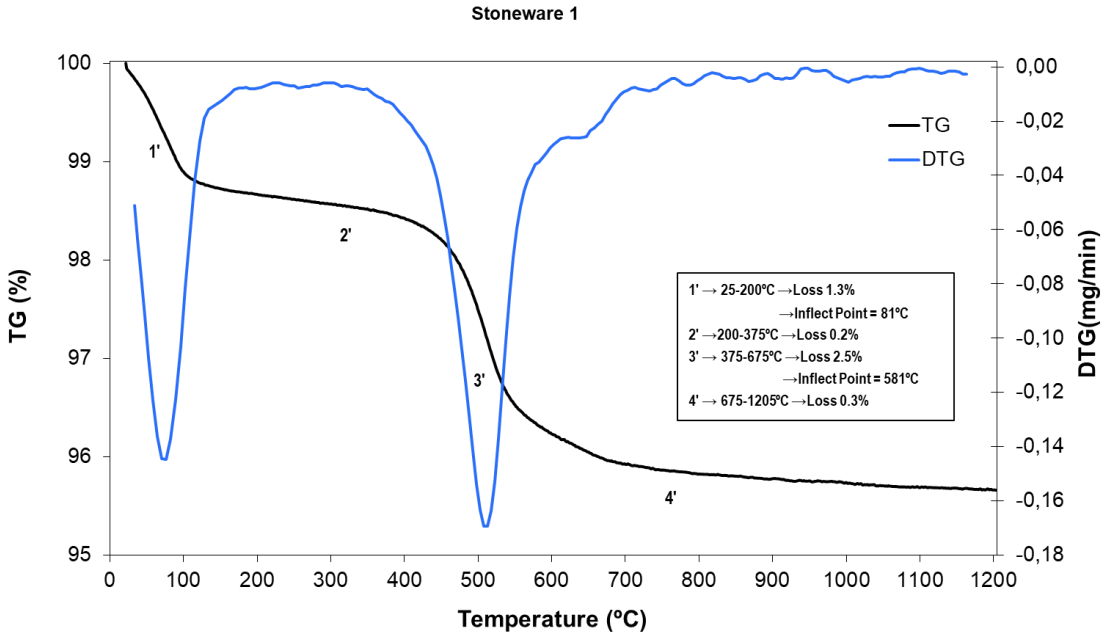
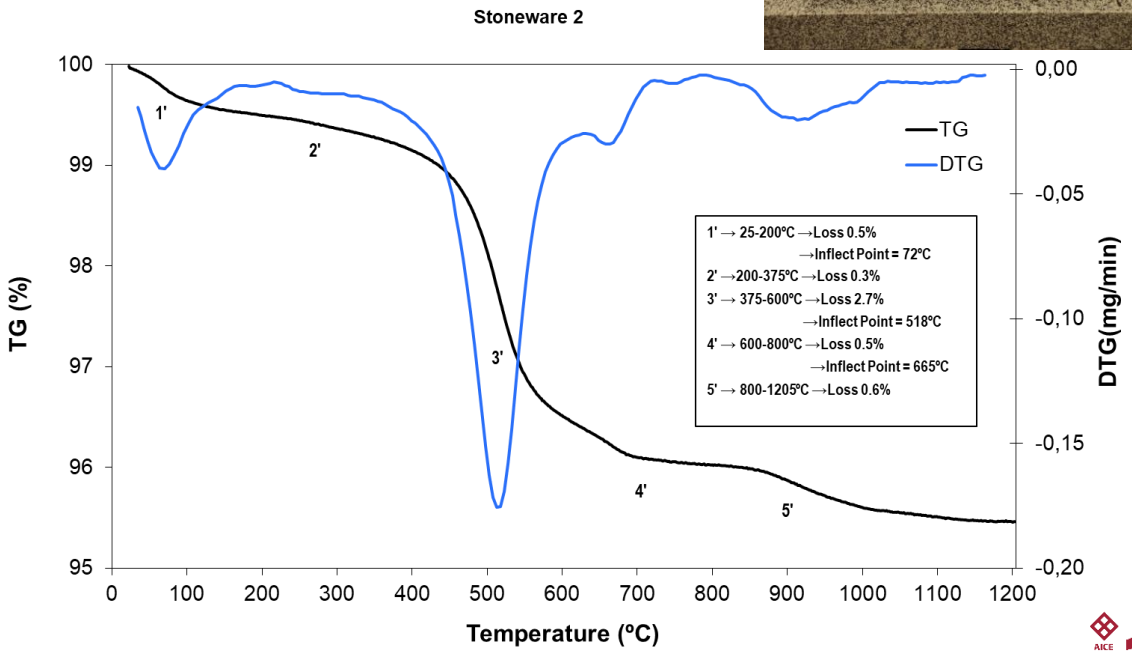
# STONEWARE CHARACTERIZATION



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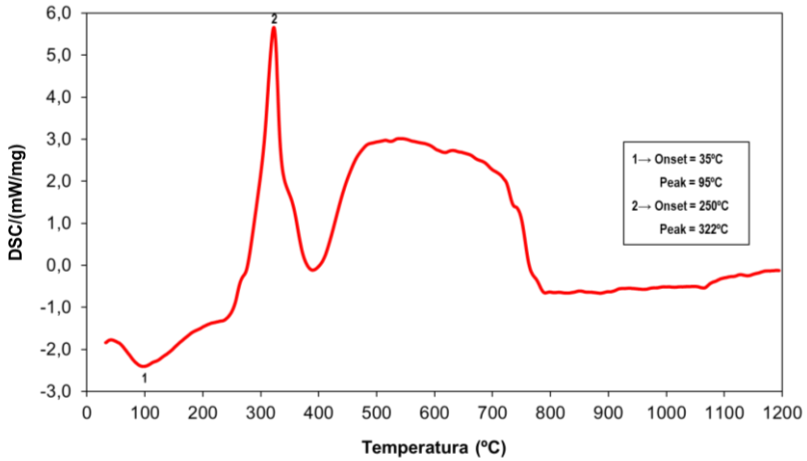
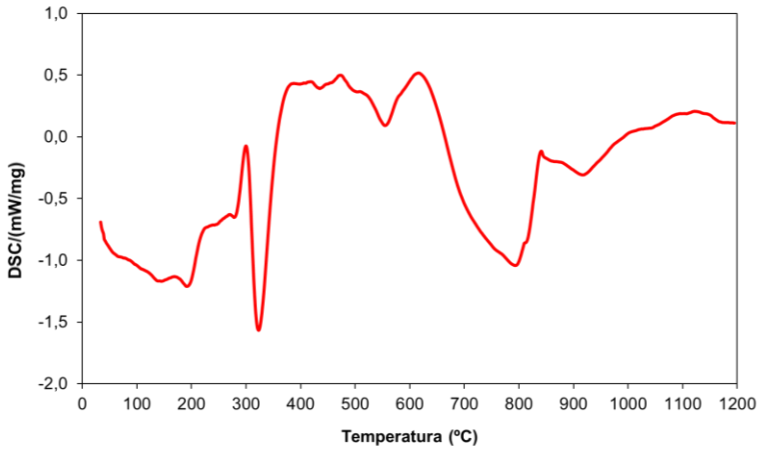
# ADDITIVES CHARACTERIZATION

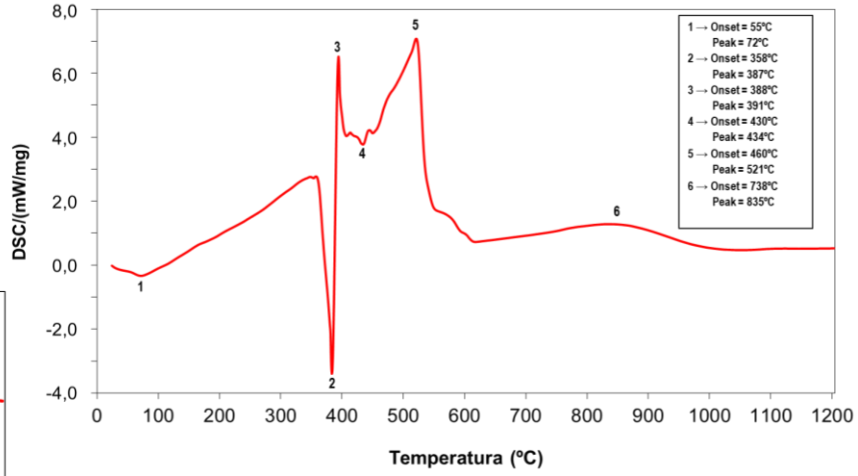
Gum 1



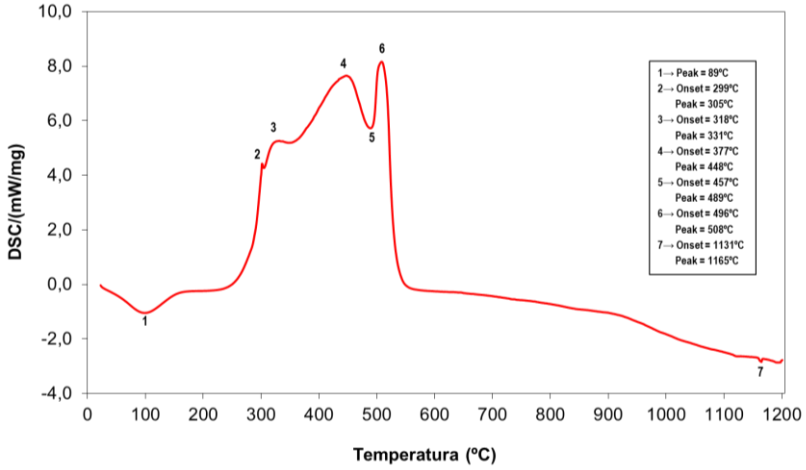

Gel




Gum 2




Gum 3

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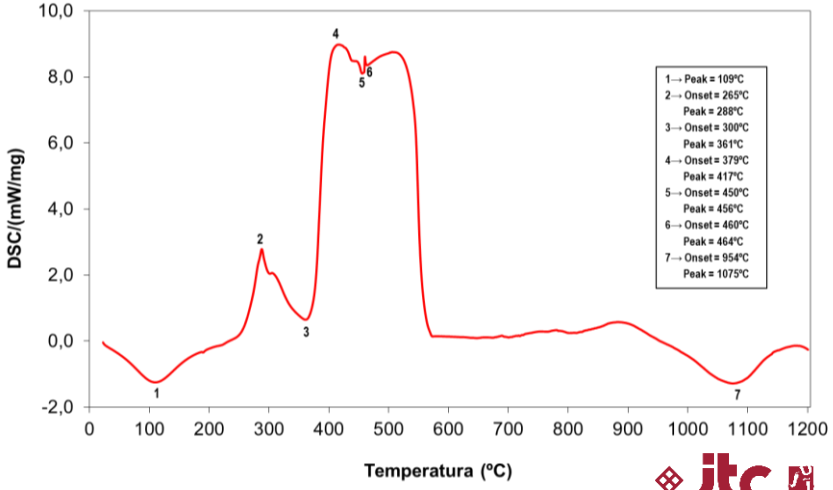


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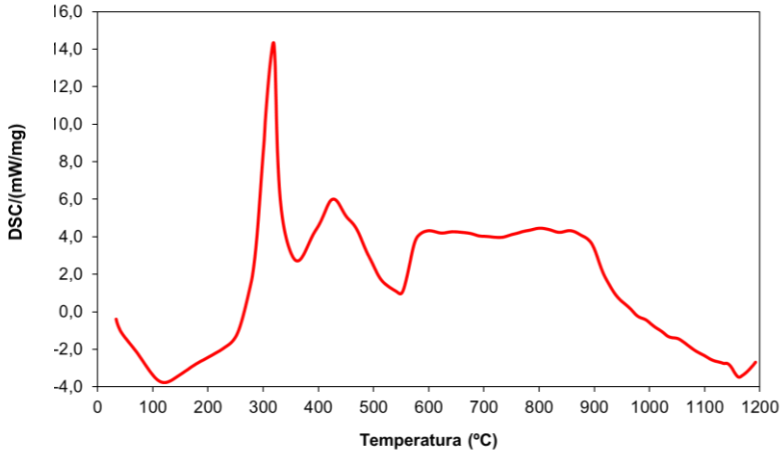
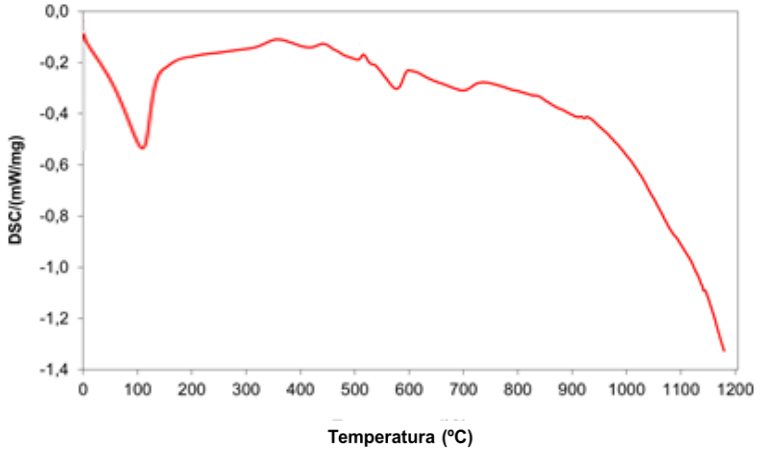
# ADDITIVES CHARACTERIZATION

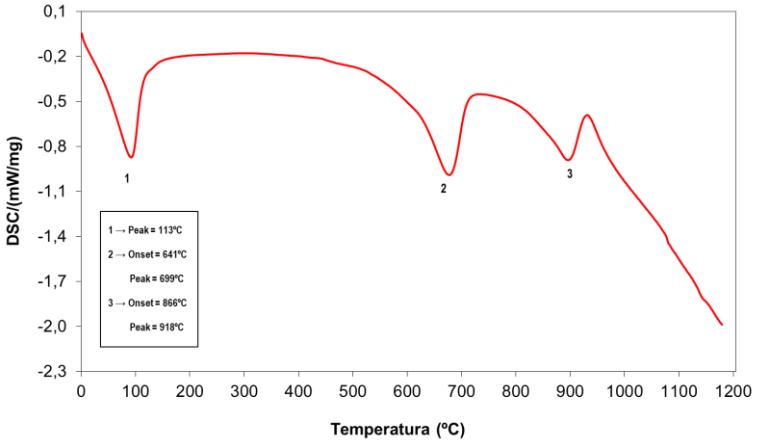
Synthetic thickener 1



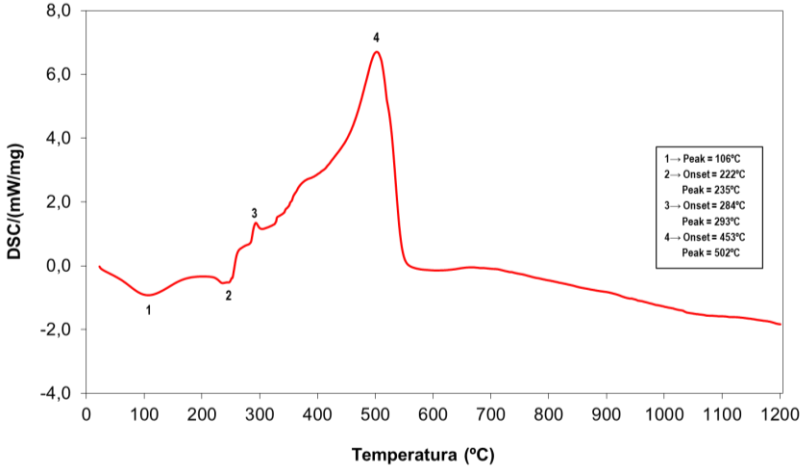

Mineral 1



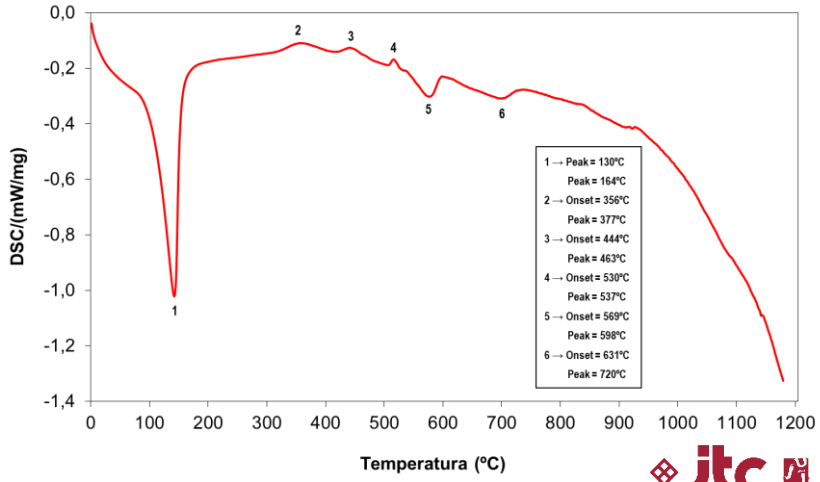

Mineral 3




Synthetic thickener 2




Mineral 2

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# COMPOSITIONS

Stoneware 1

| | | |
|---|---|---|
| C1 | 95% Stoneware<br>5% Mineral 1 | 40% |
| C2 | 90% Stoneware<br>10% Synthetic thickener 1 | 100% |
| C3 | 90% Stoneware<br>10% Gum 1 | 100% |
| C4 | 90% Stoneware<br>10% Gum 2 | 60% |
| C5 | 90% Stoneware<br>10% Synthetic thickener 2 | 0% |
| C6 | 90% Stoneware<br>10% Gum 3 | 90% |

Printing unsuccessful

Very brittle in green

Stoneware 2

| | | |
|---|---|---|
| C7 | 90% Stoneware<br>10% Gum 1 | 100% |
| C8 | 90% Stoneware<br>10% Gum 4 | 0% |
| C9 | 90% Stoneware<br>10% Mineral 2 | 70% |
| C10 | 99% Stoneware<br>1% Mineral 3 | 100% |
| C11 | 90% Stoneware<br>5% Gum 1<br>5% Gel 1 | 90% |
| C12 | 90% Stoneware<br>5% Gum 1<br>5% Gel 1 | 100% |
| C13 | 90% Stoneware<br>5% Gum 1<br>5% Synthetic thickener 1 | 100% |

Printing unsuccessful

Better green strength

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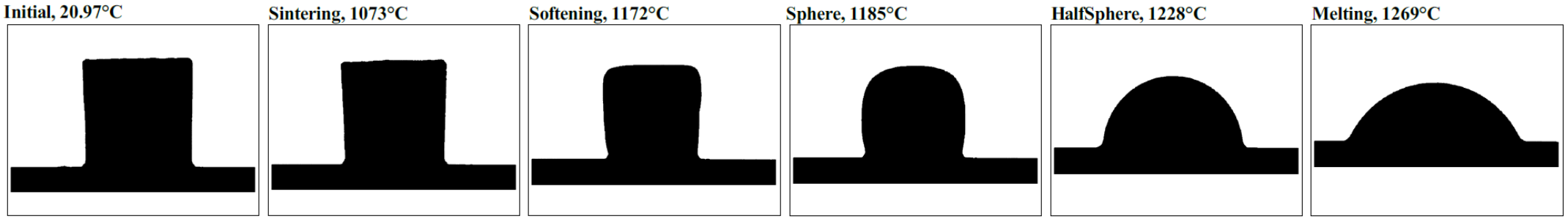
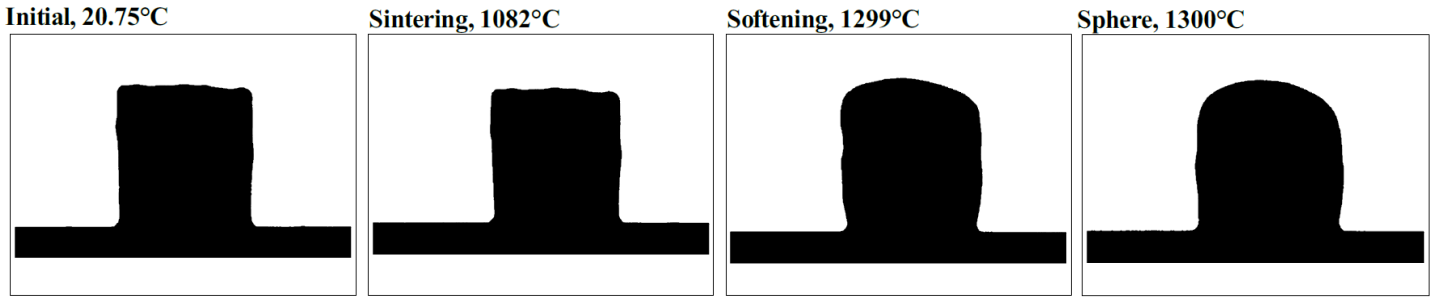
# COMPOSITIONS CHARACTERIZATION

Stoneware + Gums




Stoneware + Gel



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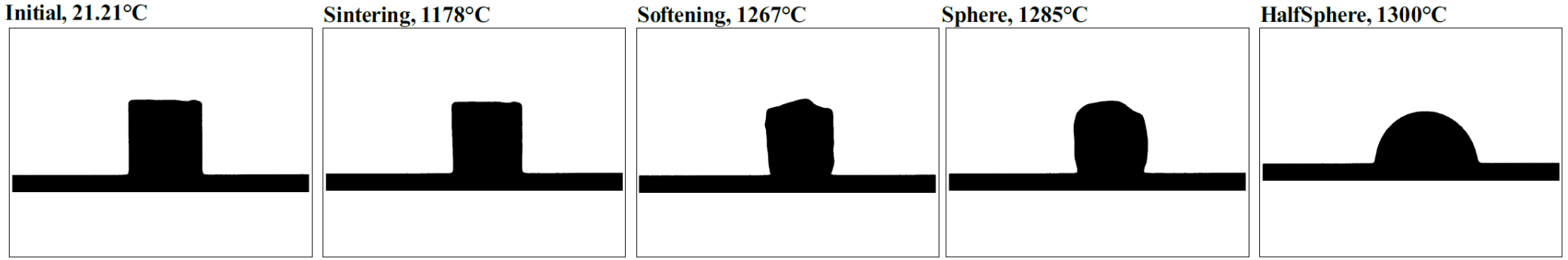
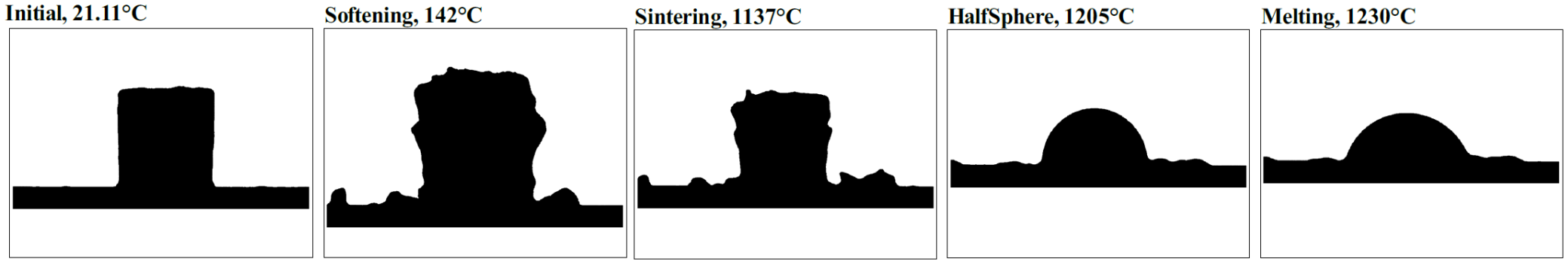
# COMPOSITIONS CHARACTERIZATION

Stoneware + Minerals




Stoneware + Synthetic thickeners

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# PRINTING PARAMETERS

**Printer:** ZPrinter 310 (Zcorp)

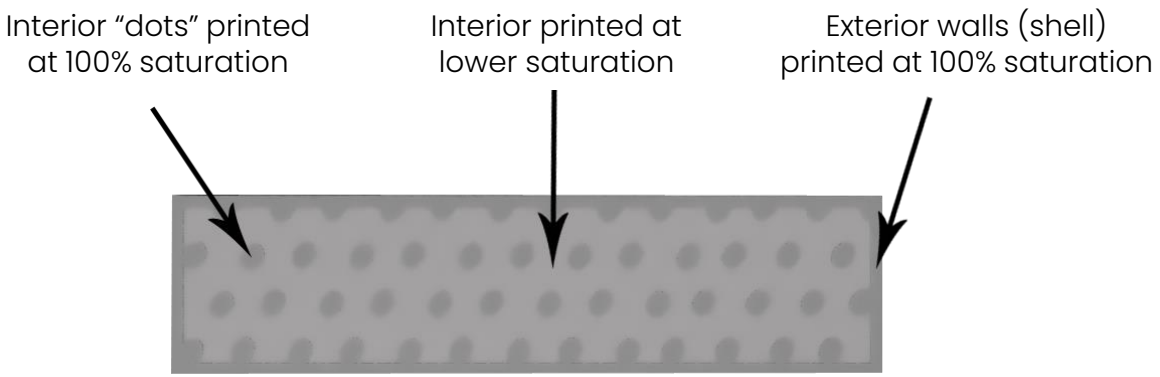
**Layer height:** 0,1 mm

**Binder:** Water, surfactant and alcohol, with a viscosity of 1.1 to 1.3 Pa-s and high surface tension.

**Temperature:** 20ºC (room temperature)

**Slow axis speed:** 120000 pps

**Saturation**: 100%*

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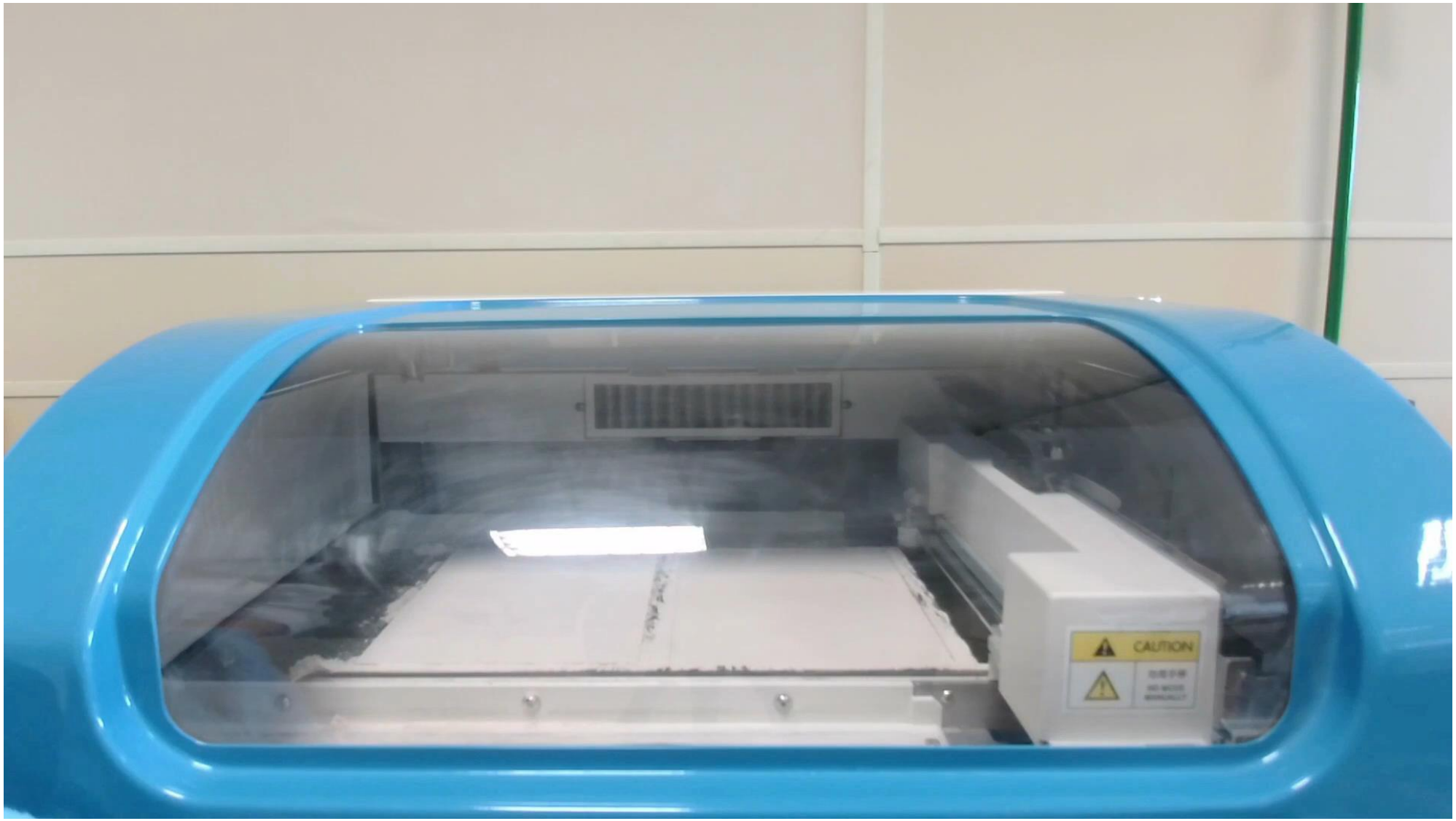


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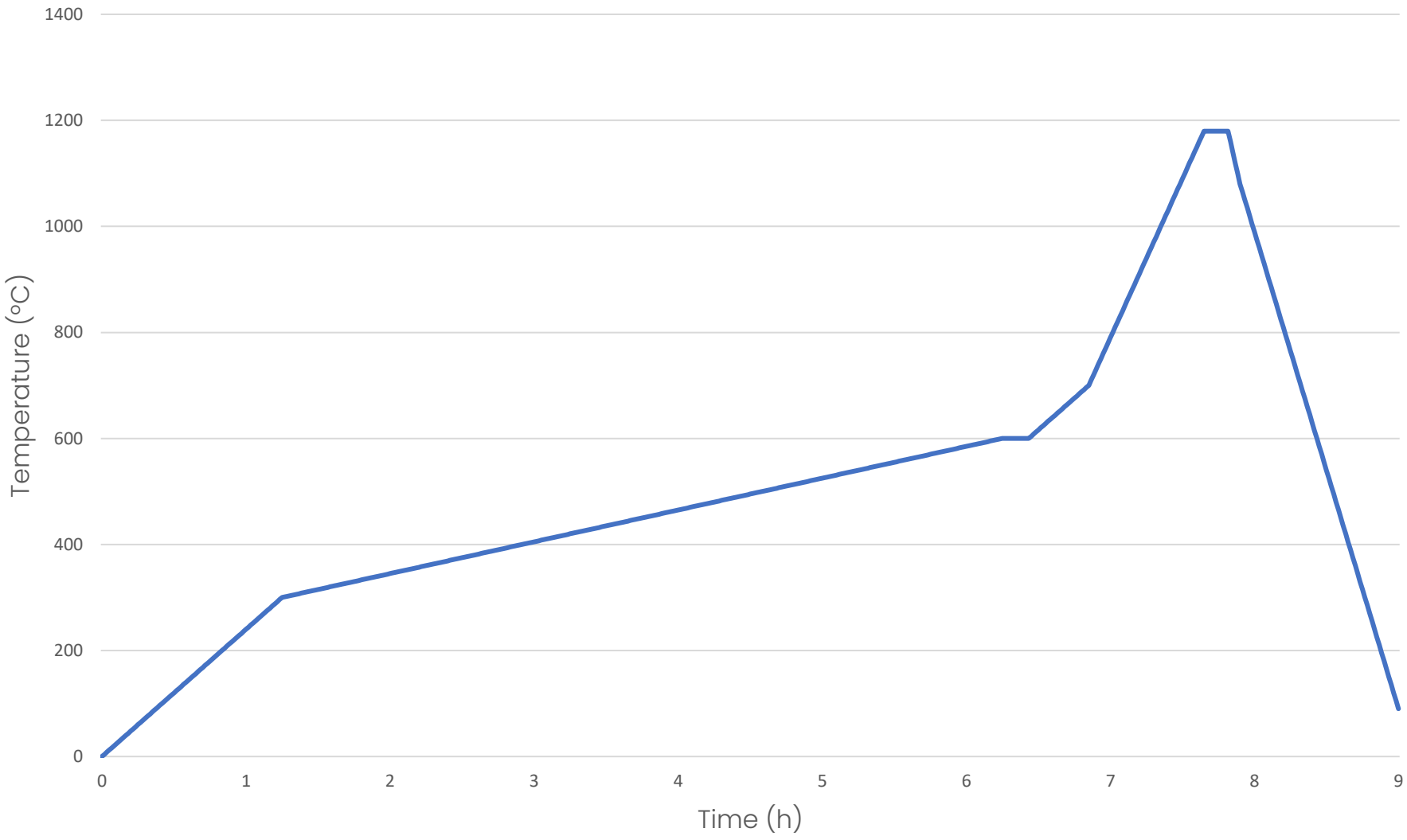
# POSTPROCESSING

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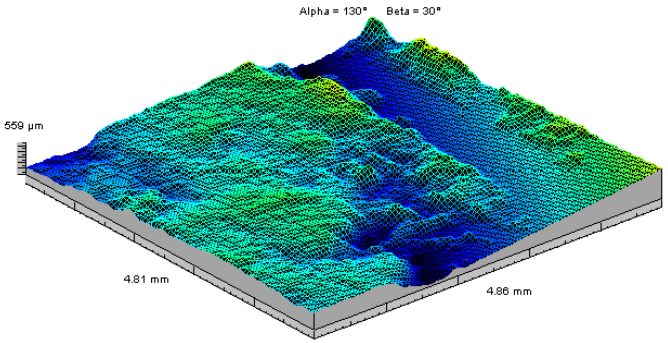
# SURFACE ROUGHNESS

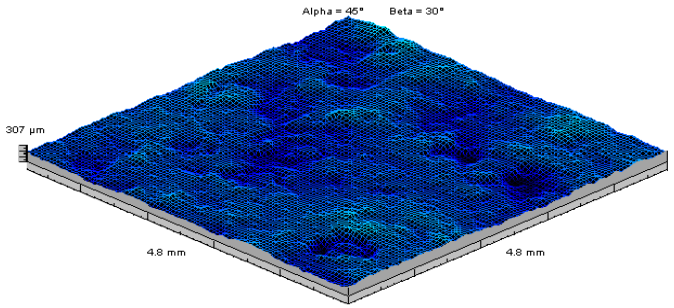
C1




Ra= 14,24±5,27µm

RzISO= 77,19±26,80µm

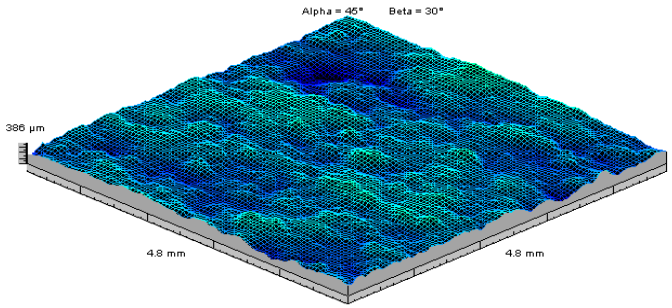
C2




Ra= 12,55±2,35µm

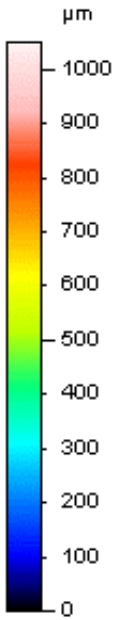
RzISO= 70,58±11,57µm

C3

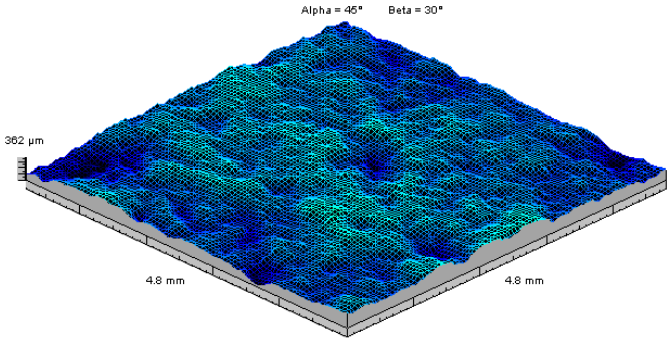



Ra= 17,20±1,97µm

RzISO= 87,60±8,69µm



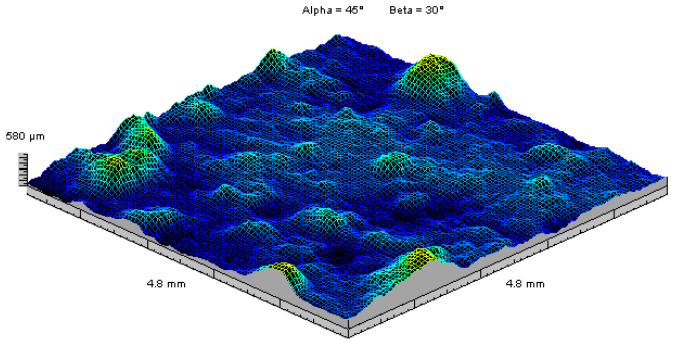

C4




Ra= 17,06±1,88µm

RzISO= 88,21±8,43µm

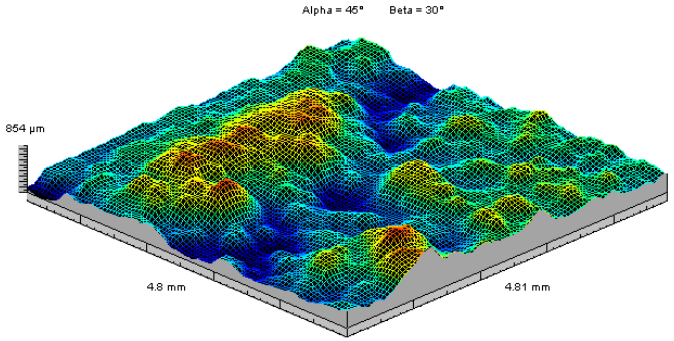
C6




Ra= 20,28±4,67µm

RzISO= 100,57±20,34µm

C7

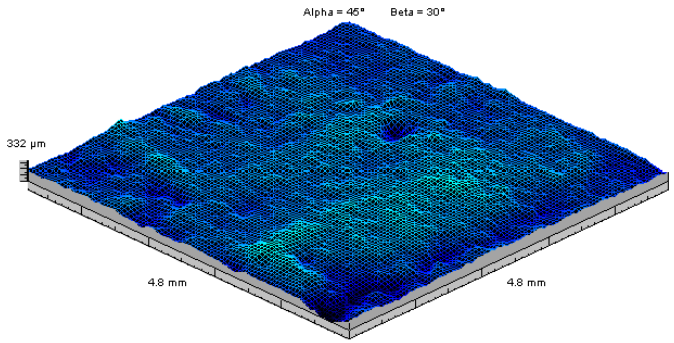



Ra= 28,22±7,40µm

RzISO= 125,54±29,11µm

# SURFACE ROUGHNESS

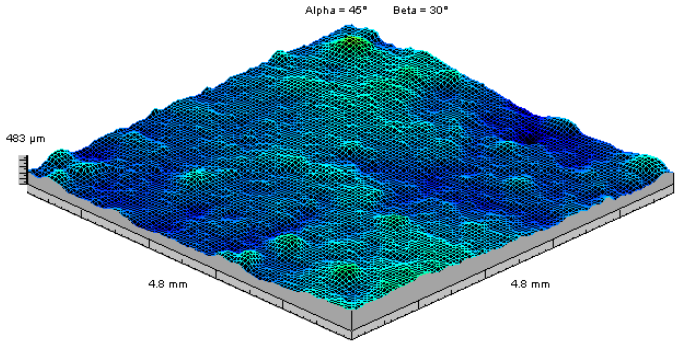
C9




Ra= 12,01±1,85µm

RzISO= 67,05±9,02µm

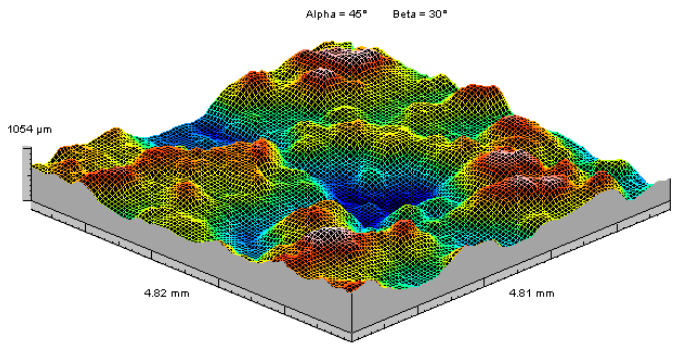
C10




Ra= 13,67±2,50µm

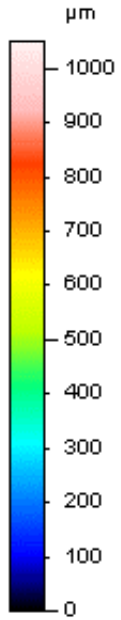
RzISO= 72,06±11,10µm

C11

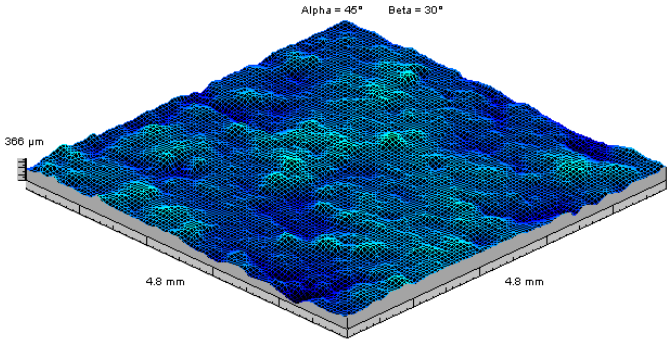



Ra= 28,83±5,38µm

RzISO= 124,74±21,41µm



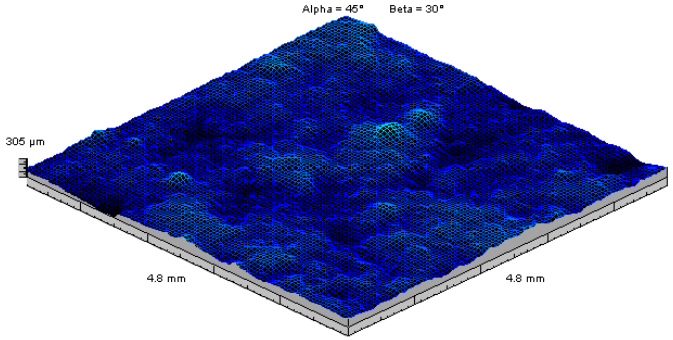

C12




Ra= 14,31±1,88µm

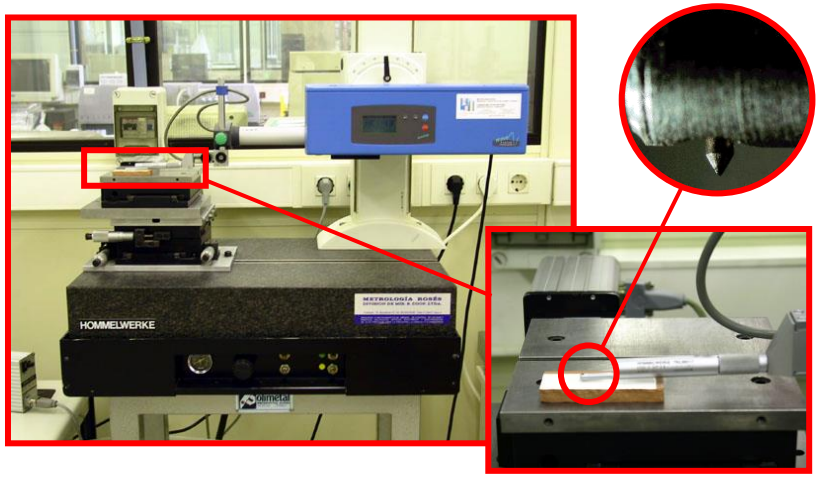
RzISO= 75,99±9,14µm

C13

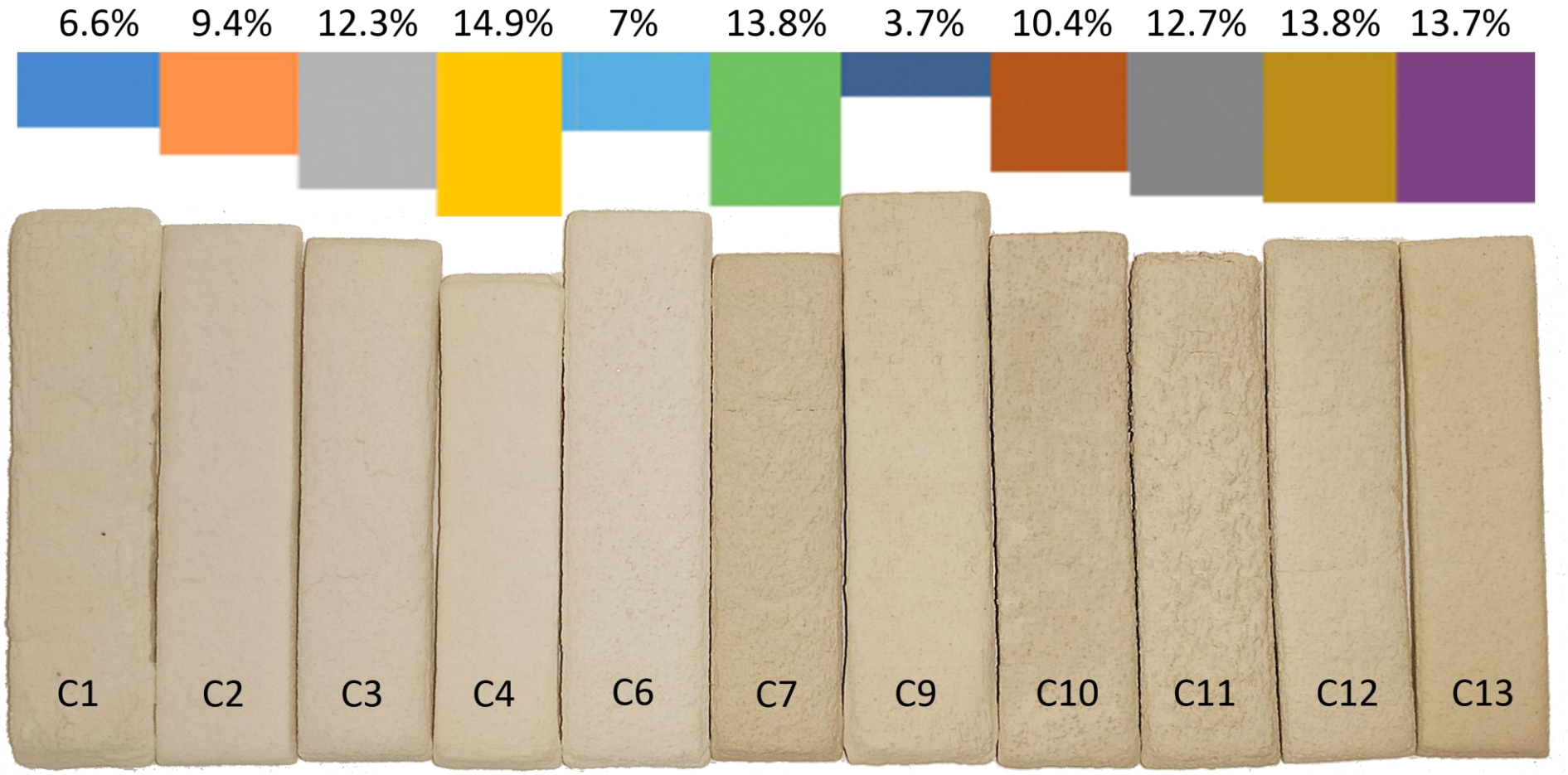



Ra= 10,55±1,71µm

RzISO= 57,36±7,34µm



# CONTRACTION

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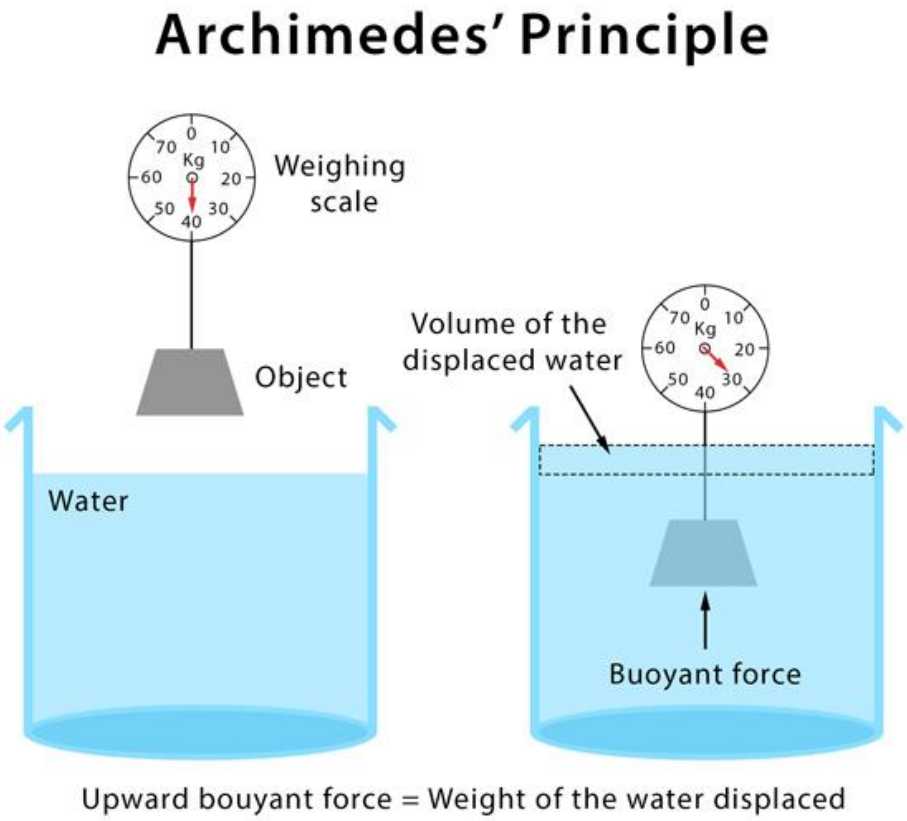
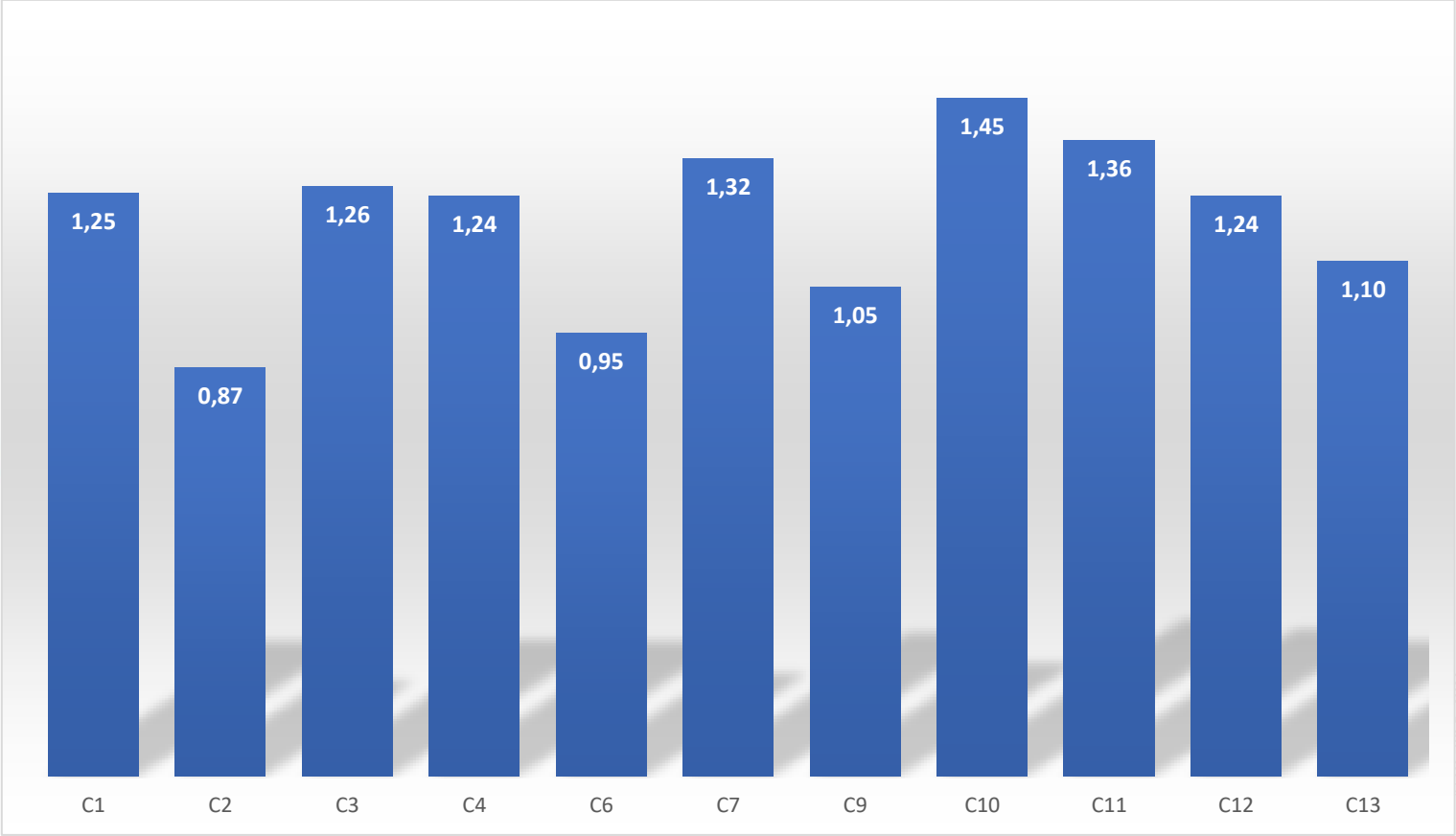
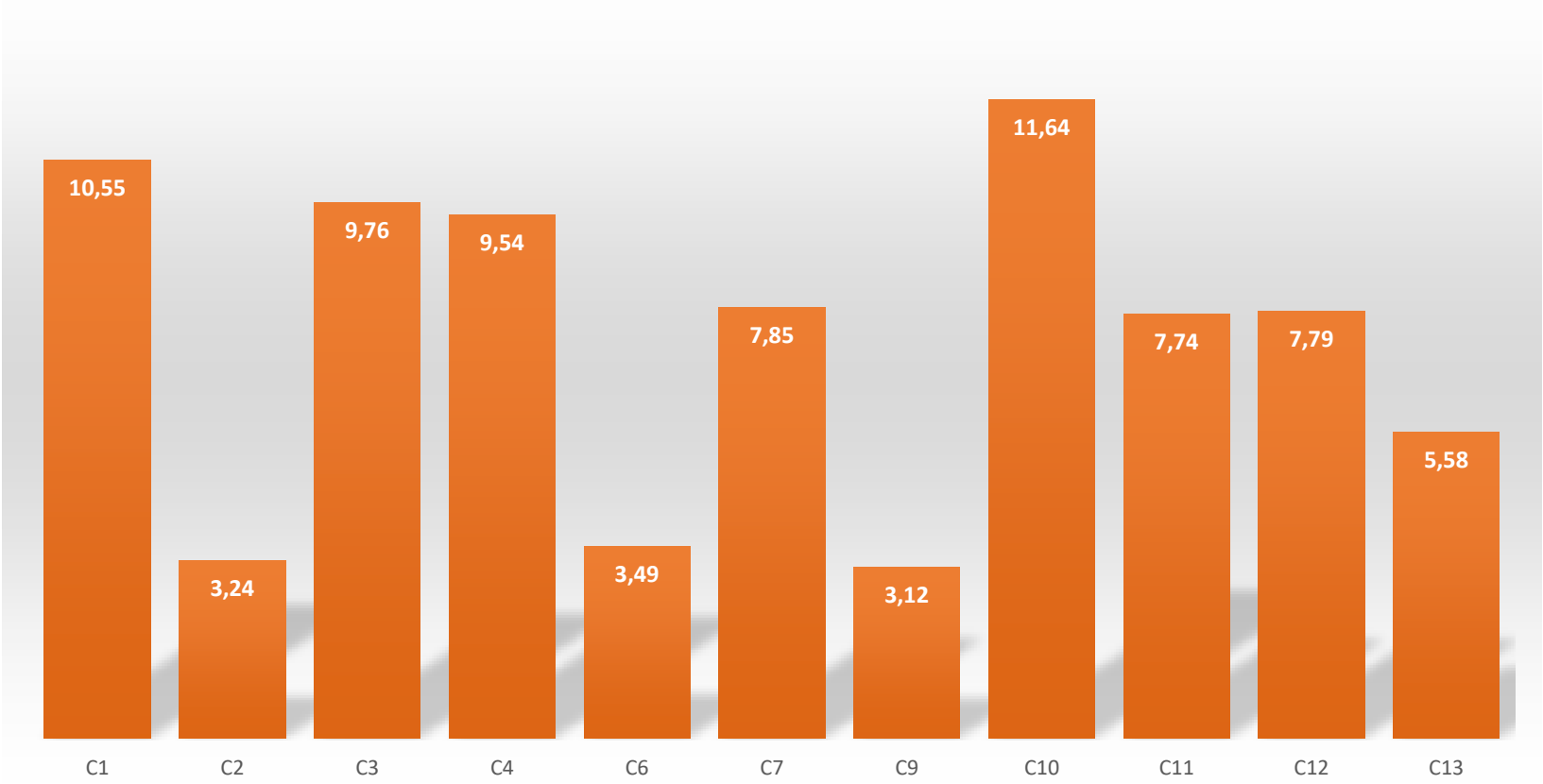
# APPARENT DENSITY



# FLEXURAL MECHANICAL STRENGTH



v= 5mm/min

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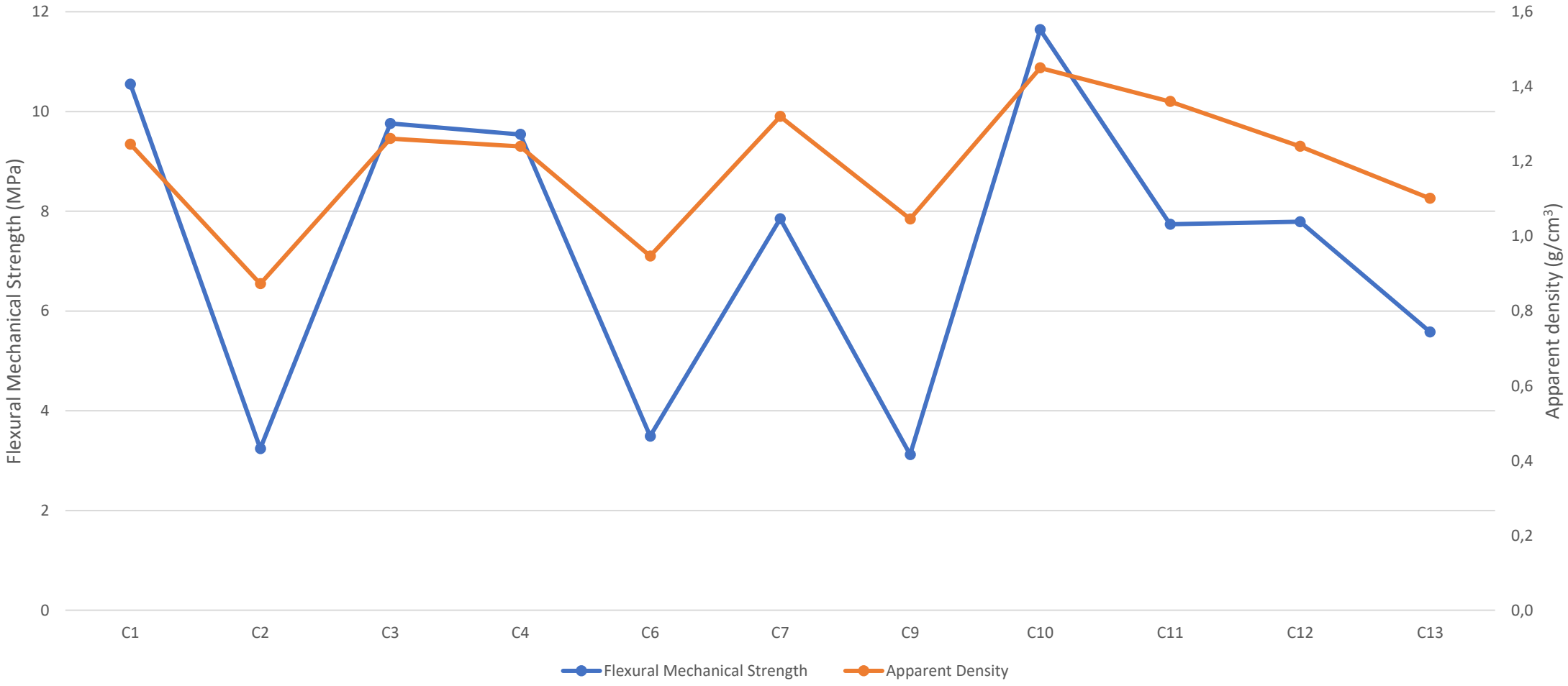
# DENSITY - STRENGTH

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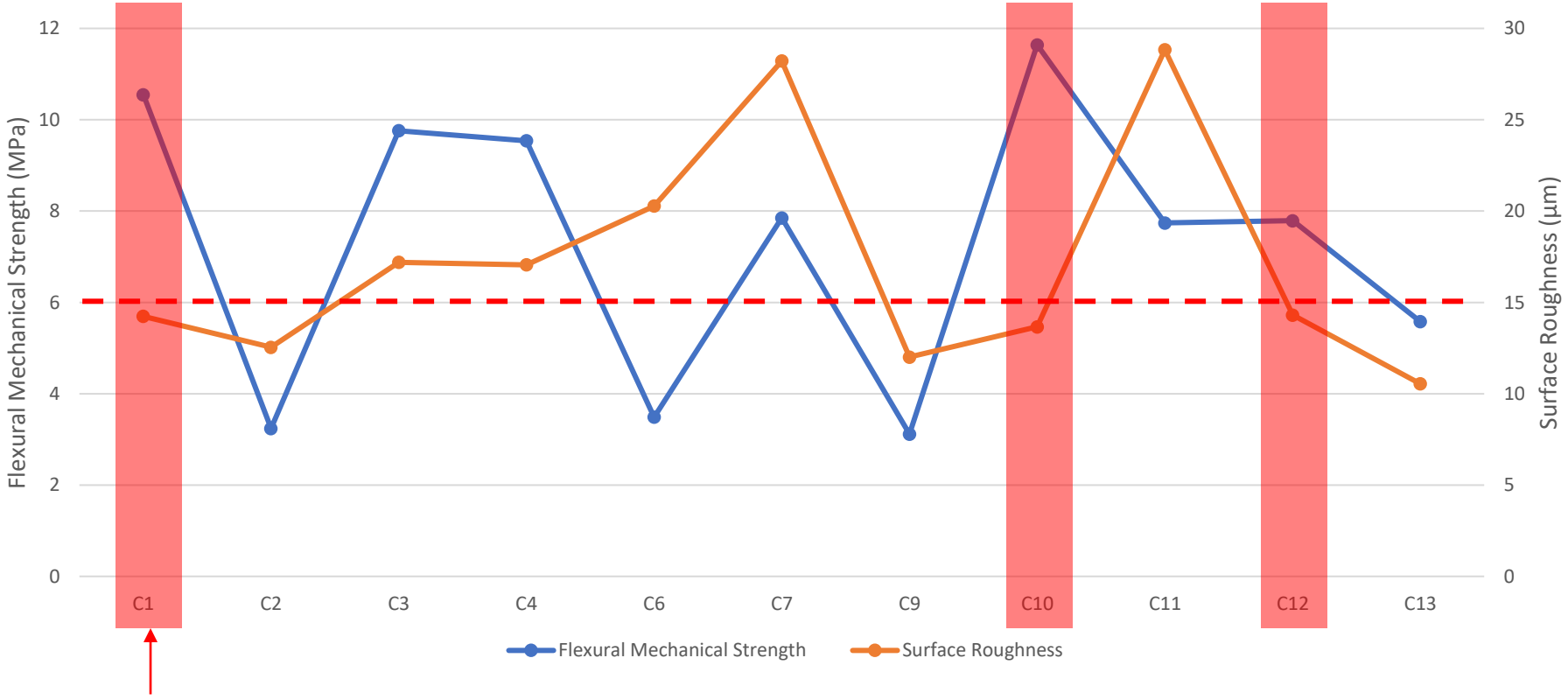
# VALIDATION




40% broken pieces
(Brittleness in green)

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# VALIDATION

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# Thank you

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