Sustainable raw materials for glass production

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ŞİŞECAM Science Technology and Design Center

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ICG Glass for a sustainable future

April 29 – May 03, 2024, Lloret del Mar, Spain

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Melting,energy and environmental aspects of glass production

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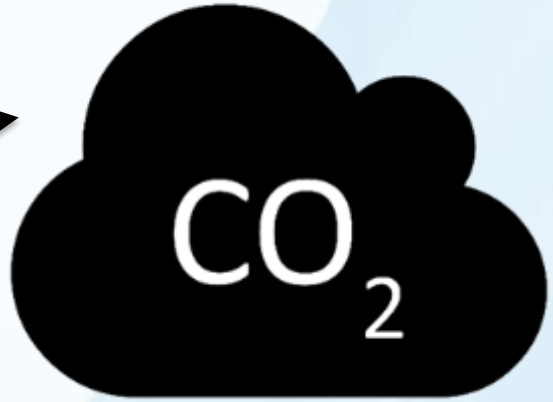


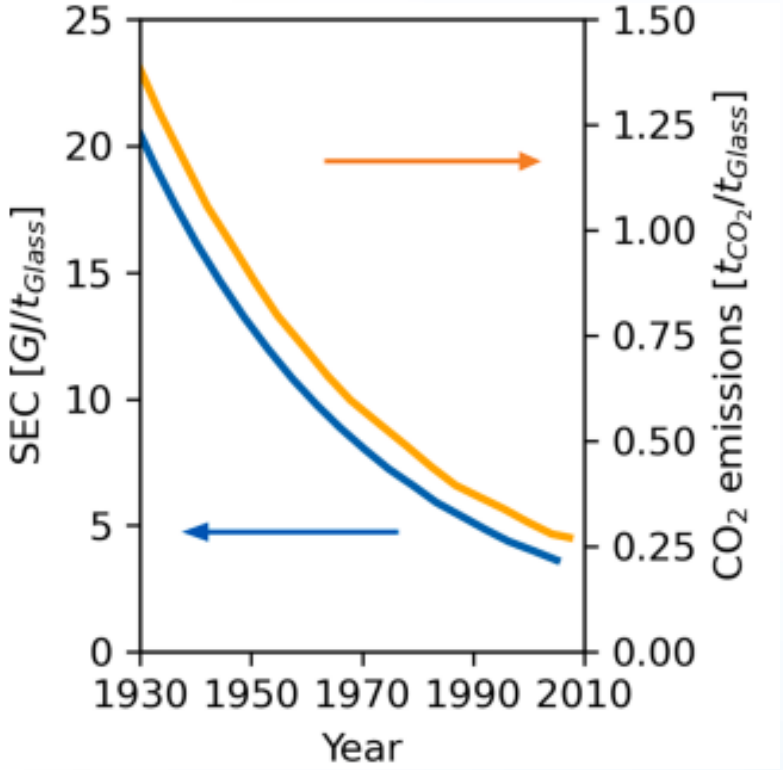
~95 million tonnes*

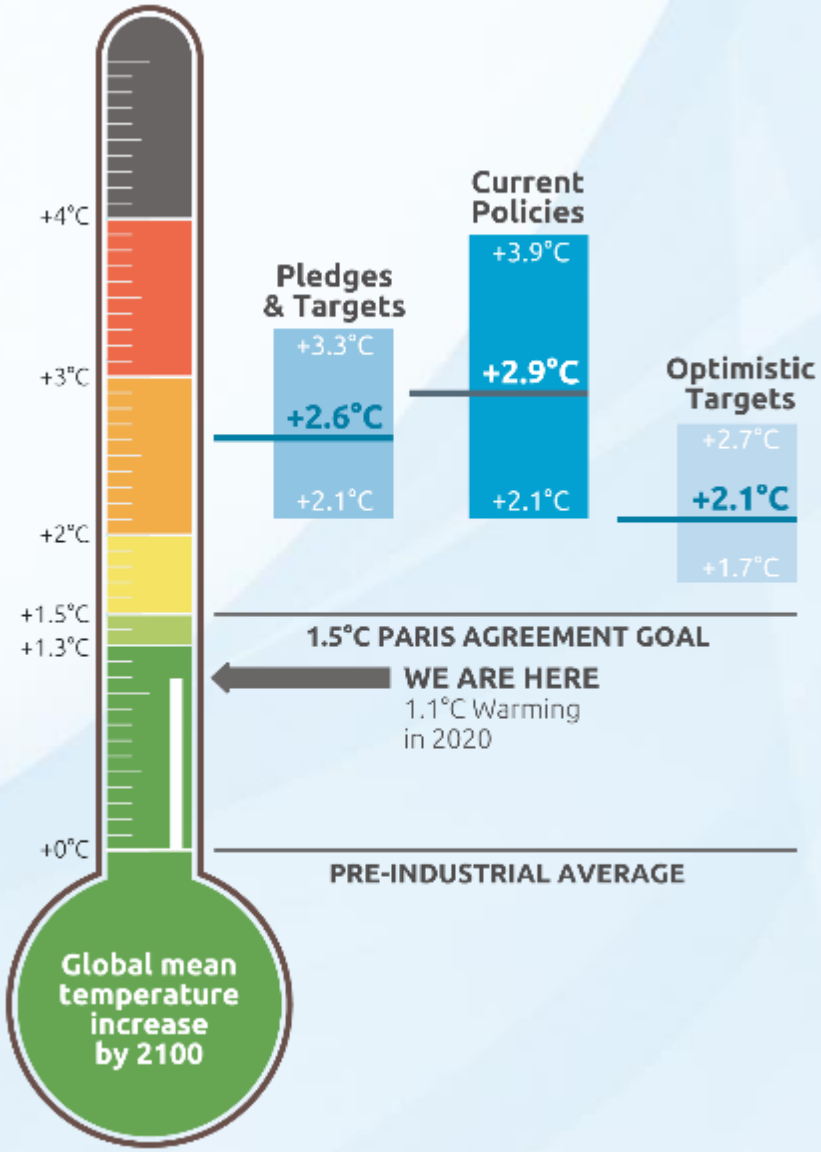
~150 million tonnes*

*Worldwide approximated numbers

Melting,energy and environmental aspects of glass production

- 2.6 GJ/t specific energy requirement for melting





- ~150 million tonnes glass production / year
- ~95 million tonnes CO_2 emission / year

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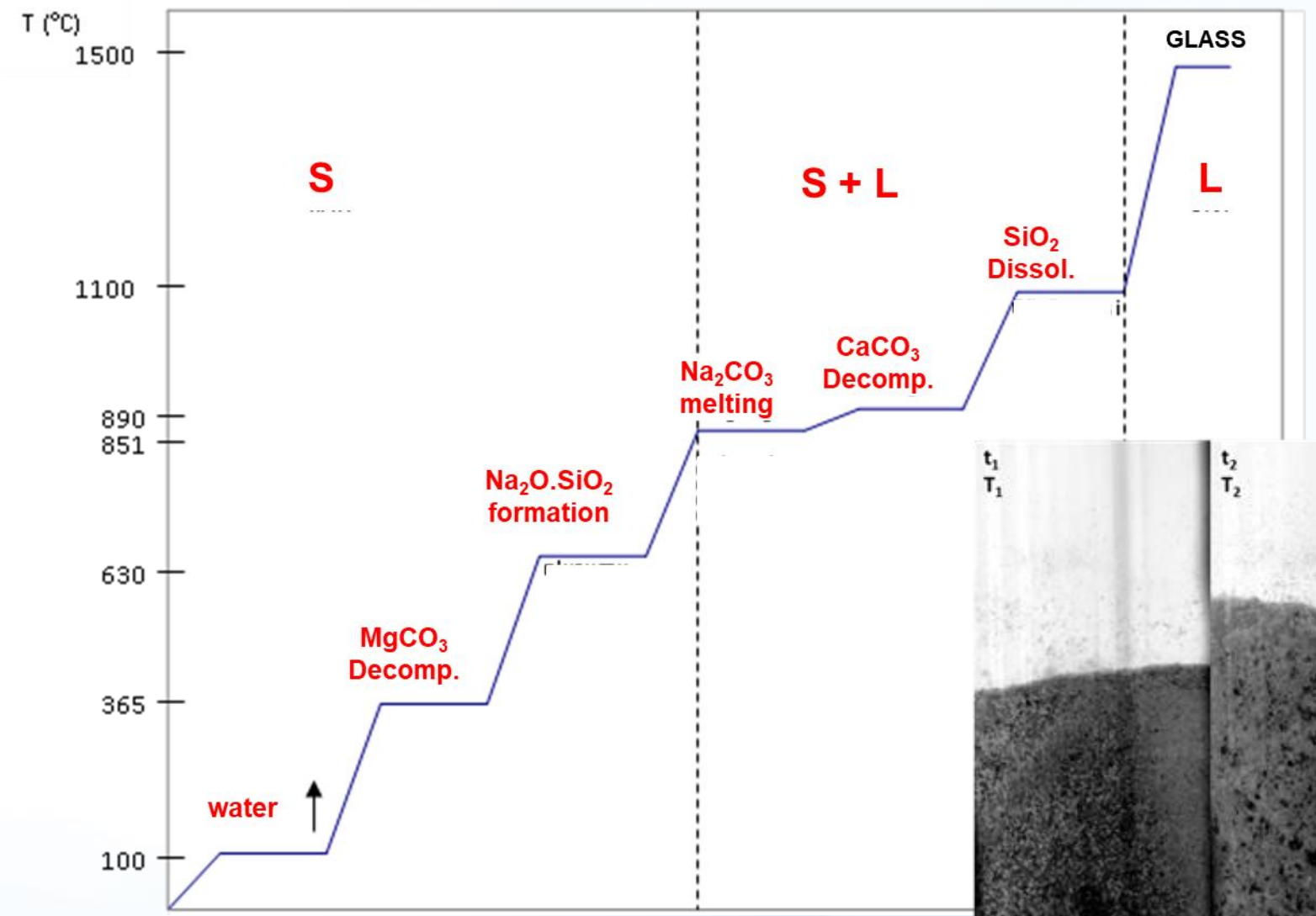
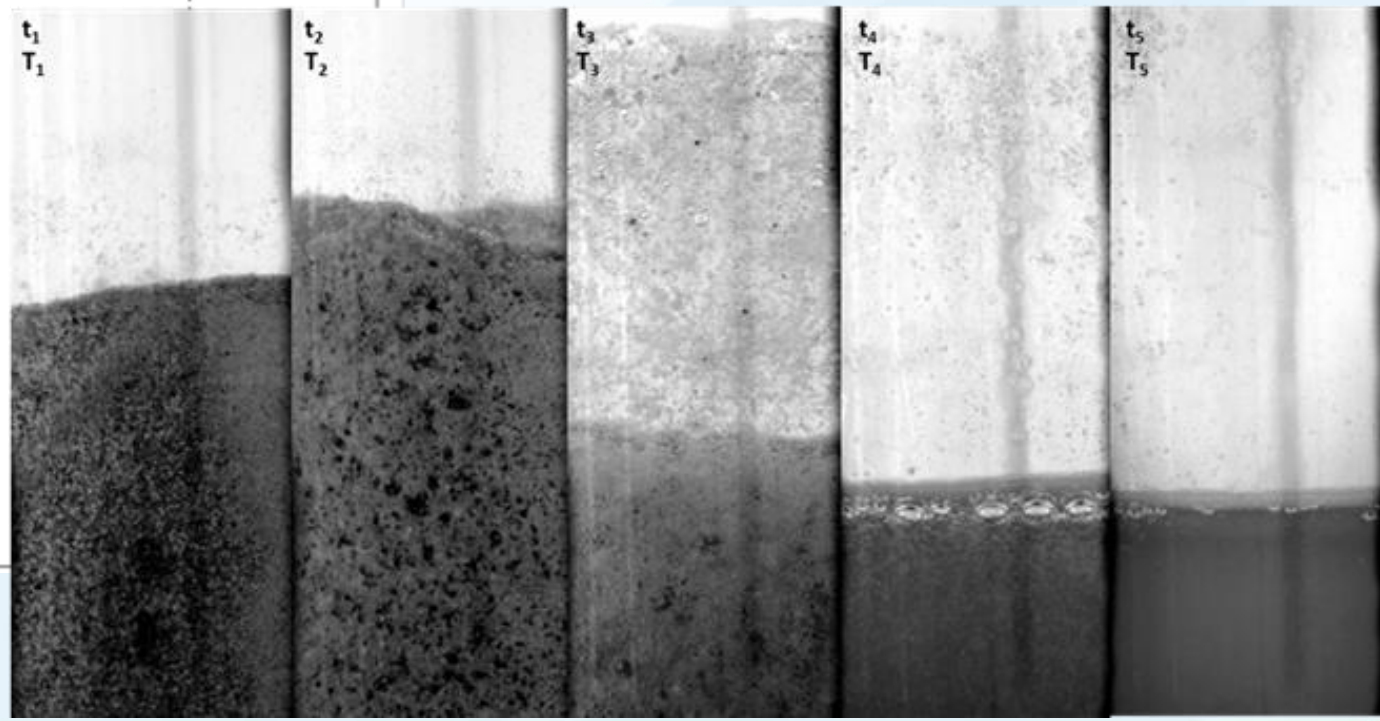
Kinetics and energetics of batch melting





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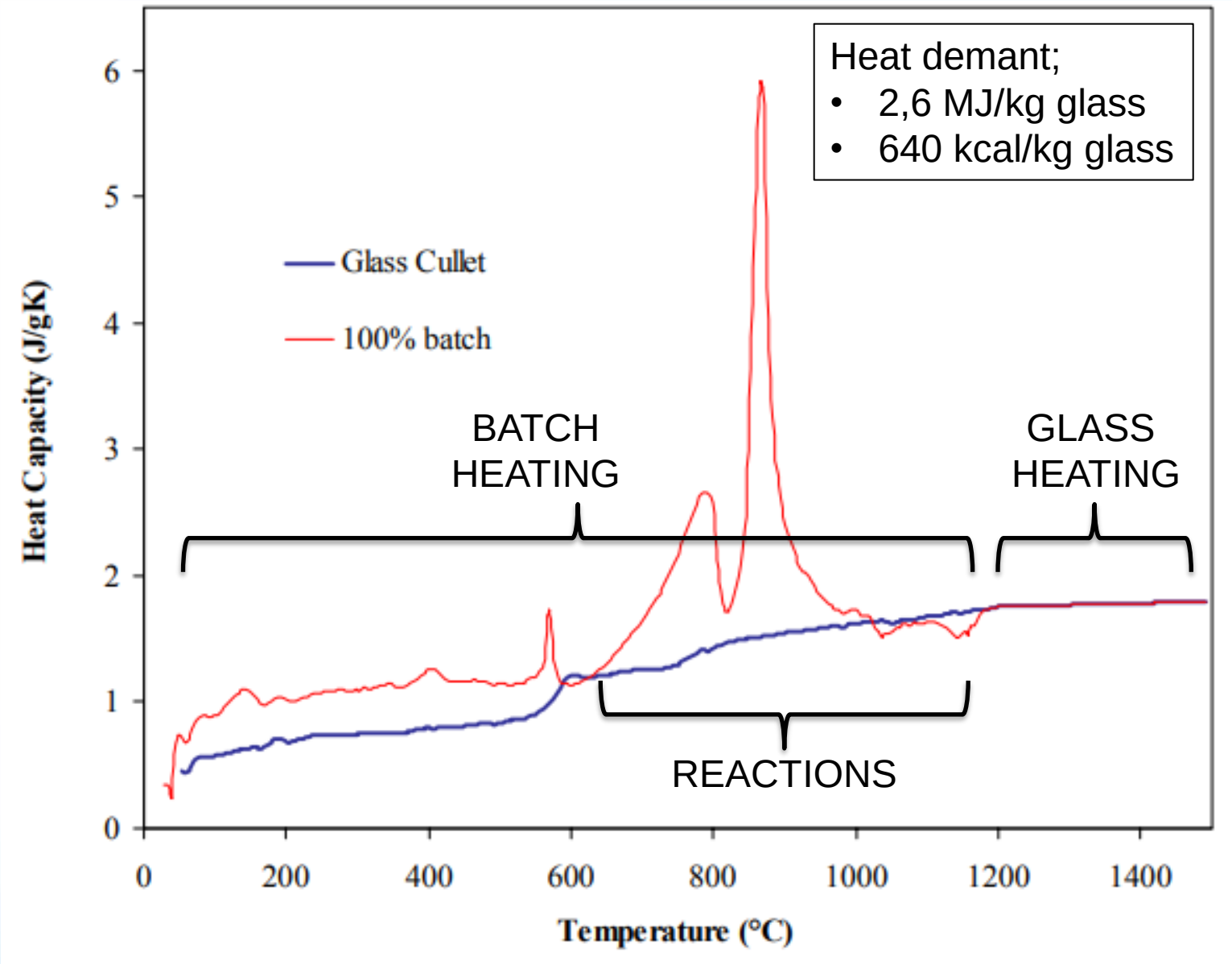
Kinetics and energetics of batch melting



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Pros and Cons of common glass making raw materials

Silica (SiO_2):
Sand, Quartzite
Feldpar

Calcium oxide (CaO):
Limestone ($CaCO_3$)
Dolomite ($CaCO_3.MgCO_3$)
Colemanite ($Ca_3B_6O_{11}.6H_2O$)

Magnesium oxide (MgO):
Dolomite ($CaCO_3.MgCO_3$)

Boron oxide (B_2O_3):
Borax anhydride ($Na_2B_4O_7$)
Borax ($Na_2B_4O_7.10H_2O$)
Boric acid (H_3BO_3)
Colemanite ($Ca_3B_6O_{11}.6H_2O$)

	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	B_2O_3
%Ağ.	69-74	0-2			8-10	0-4	13-15	0-1	

Aluminum oxide (Al_2O_3):
Feldspar
Nepheline syenite
Sand
Spodumene
Aluminum hydrates

Sodium oxide (Na_2O):
Soda ash (Na_2CO_3)
Sodium suplhate (Na_2SO_4)
Sodyum nitrate ($NaNO_3$)
Sodyum borate ($Na_2B_4O_7$)
Feldspar

Potassium oxide (K_2O):
Potassium carbonate (K_2CO_3)
Potasyum nitrate (KNO_3)
Feldspar, sand

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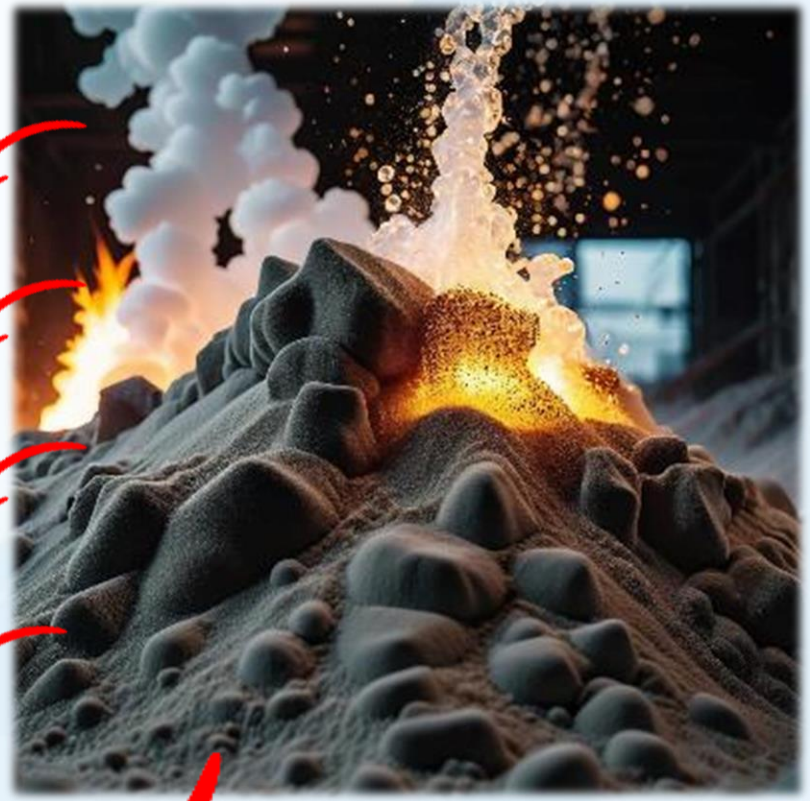
Pros and Cons of common glass making raw materials

Quality aspects

- LOCALLY AVAILABLE
- ECONOMIC
- HEAVY MINERALS
- ORGANIC CONTENT
- Fe2O3, C2O3, TiO2 Etc.

Energetic aspects



- PARTICLE SIZE
- PARTICLE SIZE MATHC
- HUMIDITY
- MINERAL IMPURITIES

NO CO_2

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Analysis methods

Multiphase approach for quality improvements

Phase 1:
Problem detection

Melting related problems

Corrosion problems

Mechanical durability related problems

Colour related problems

Phase 2:
Ideas tested in lab scale

Phase 3:
Pilot scale trials

Phase 4:
Know-how transferred to plant

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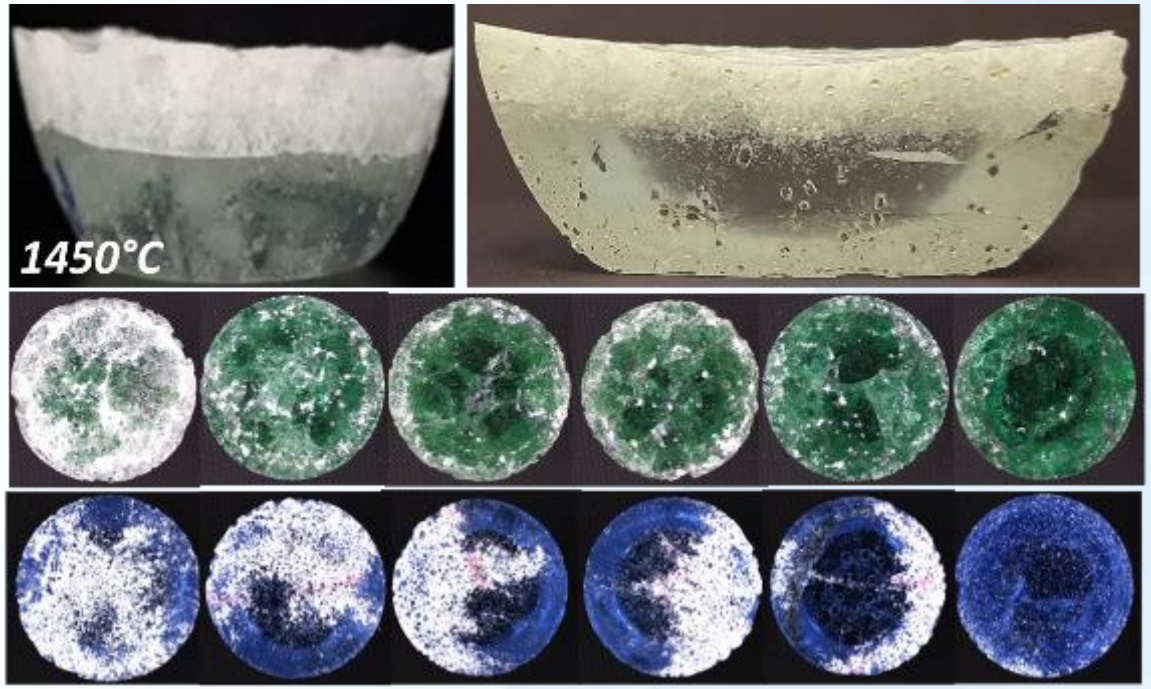
Analysis methods

Lab scale testing of all sorts of raw materials for ensuring and maintainging high product quality for flat, container, tableware and fiber product families

POT MELTING TESTS



← Improvement

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Analysis methods

Lab scale testing of all sorts of raw materials for ensuring and maintainging high product quality for flat, container, tableware and fiber product families

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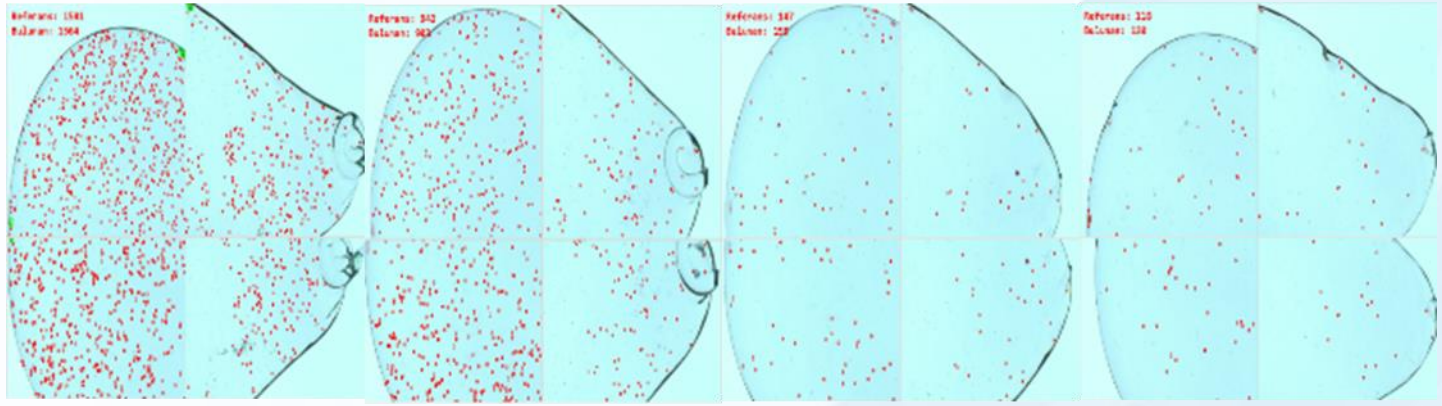

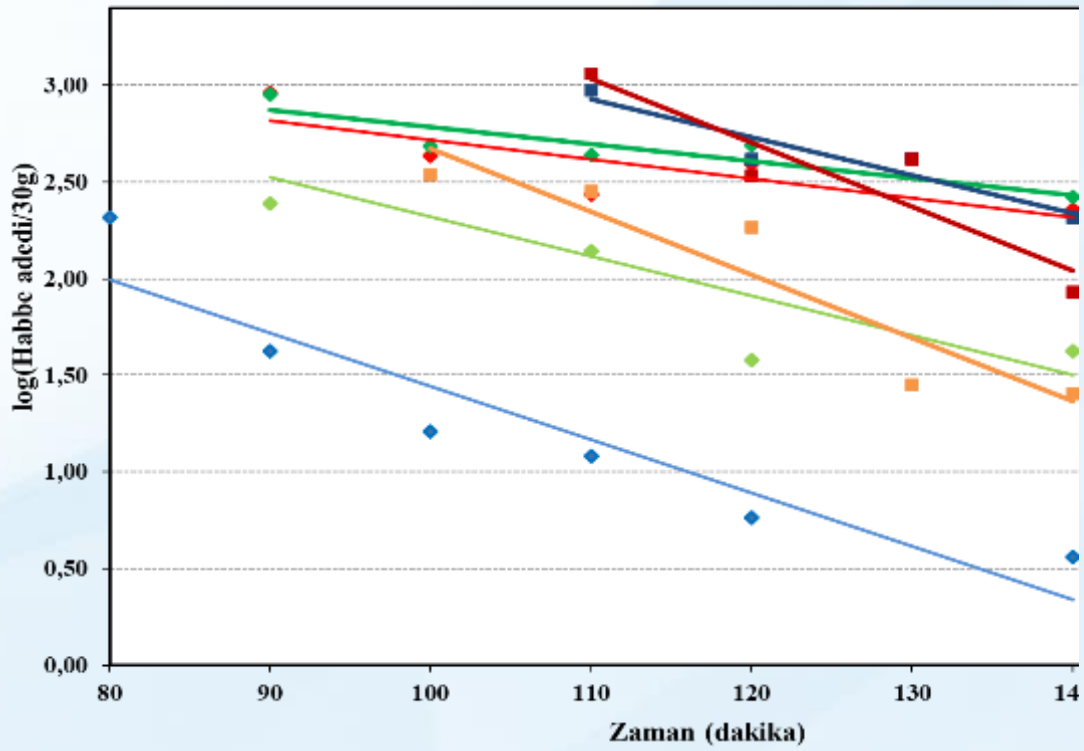

← Improvement

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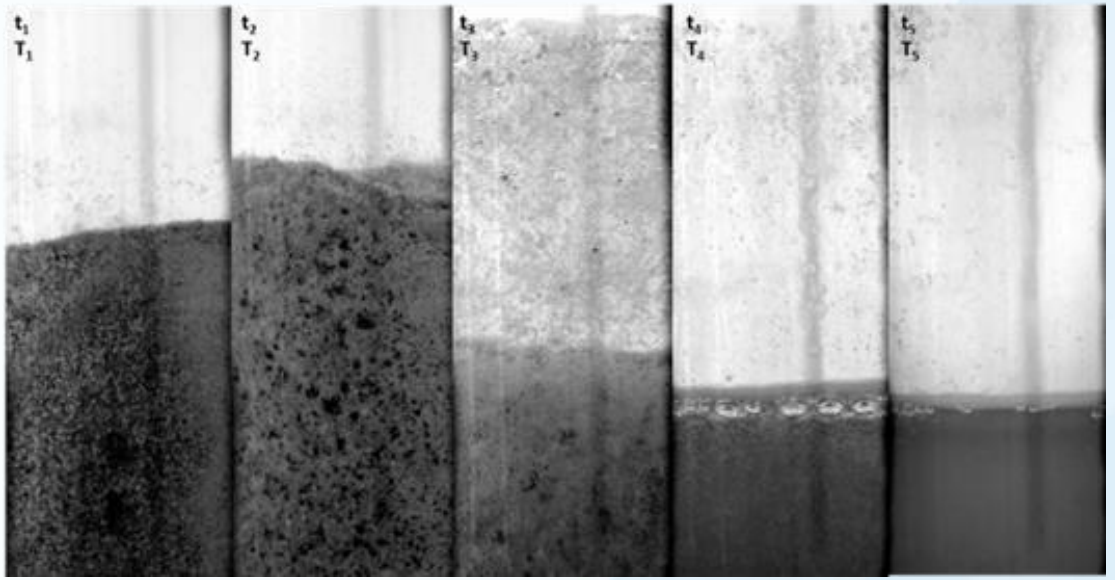
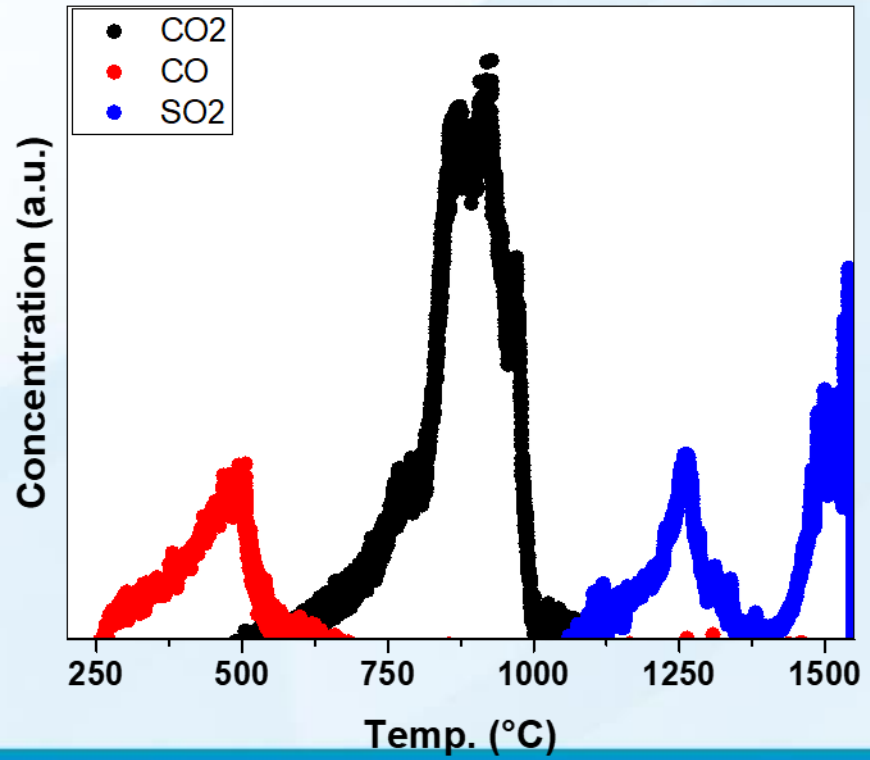
Analysis methods

Lab scale testing of all sorts of raw materials for ensuring and maintainging high product quality for flat, container, tableware and fiber product families

ADVANCED TOOLS





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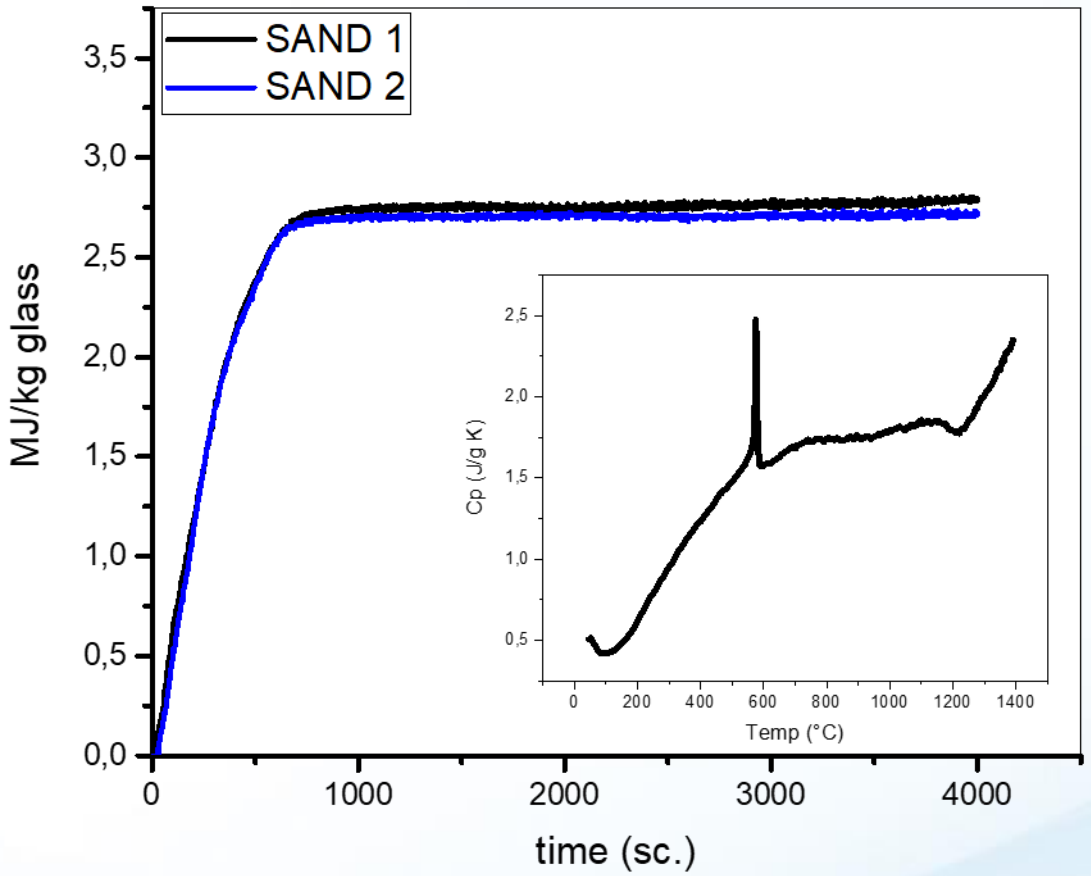
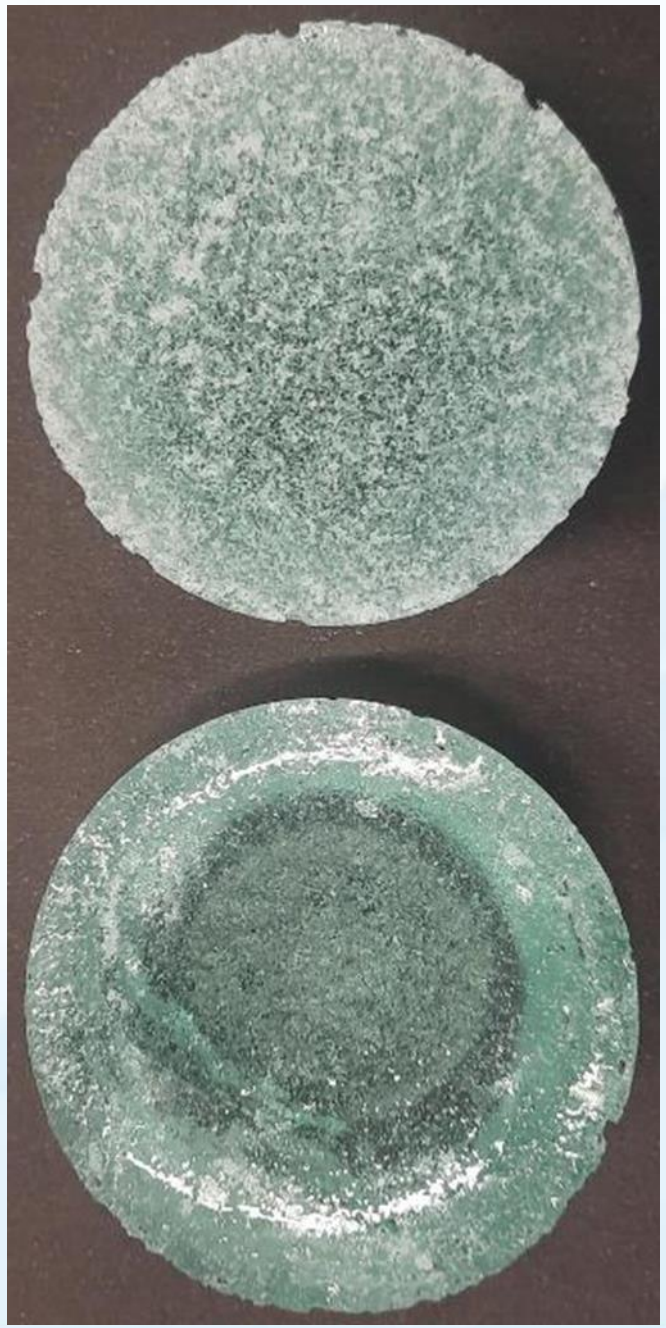
Analysis methods

Example 1: Particle size





647 kcal/kg cam

645 kcal/kg cam

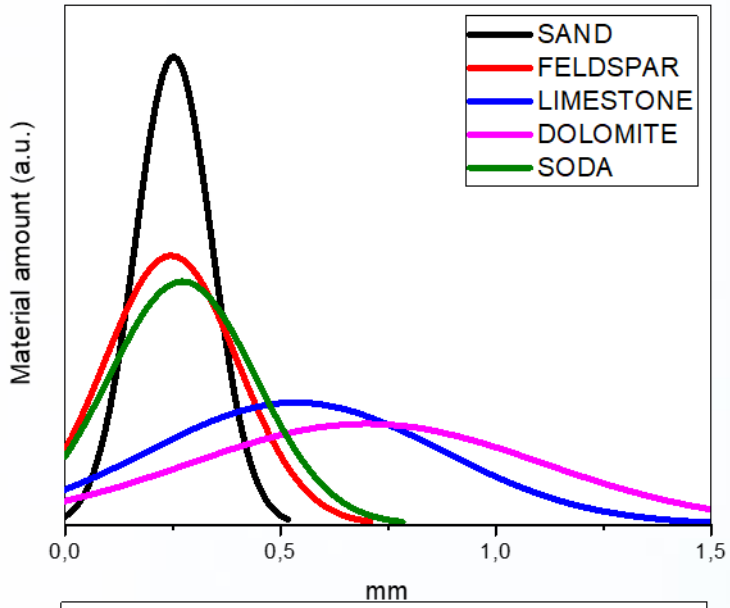
Analysis methods

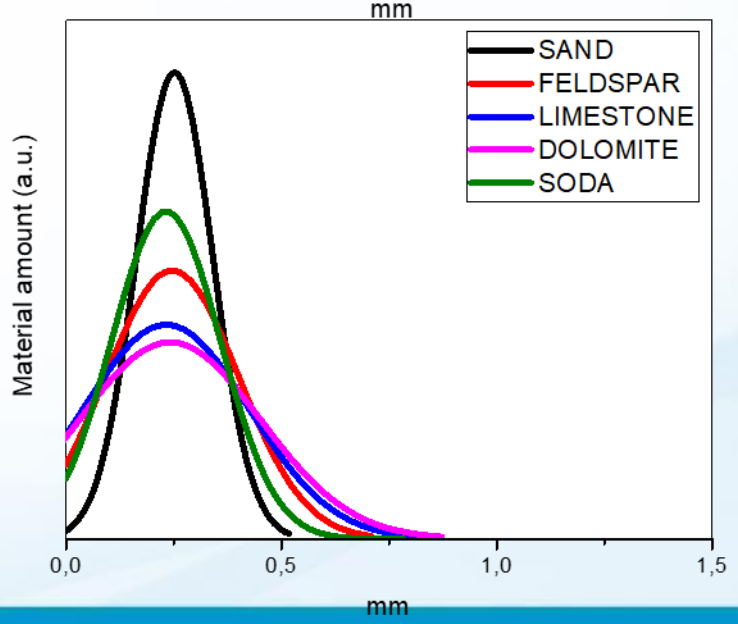
Example 2: Particle size match

BATCH 1

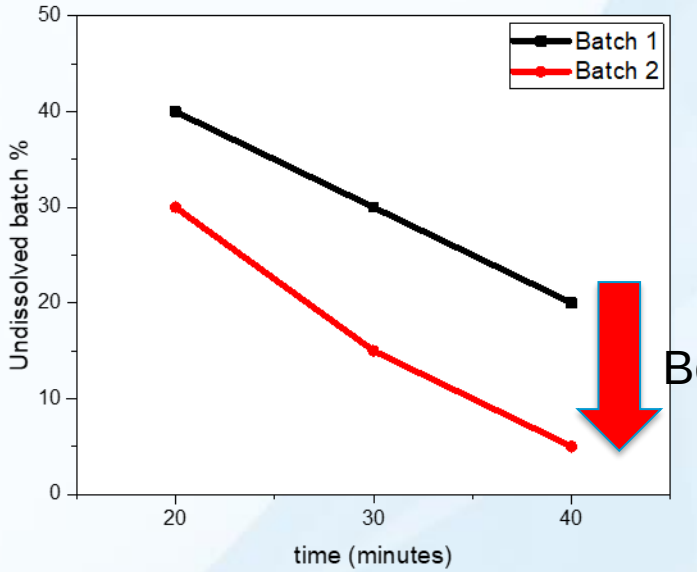
Matching mean diameters of batch materils

BATCH 2



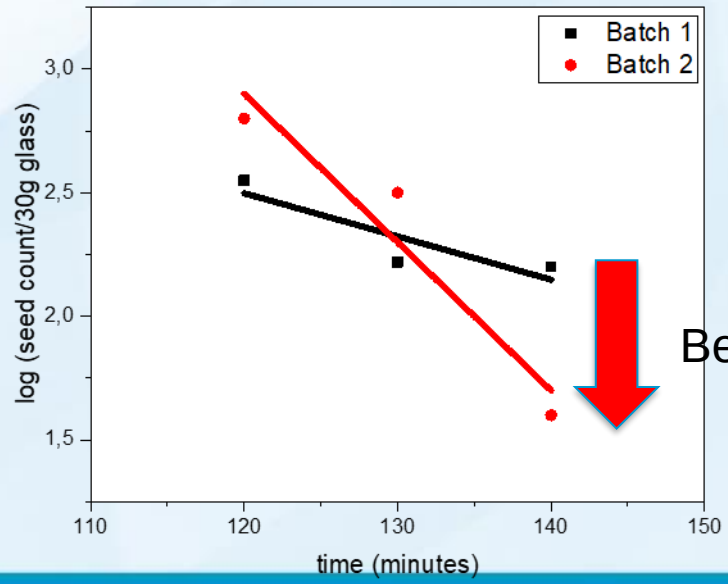


Batch free time experiment



Better melting

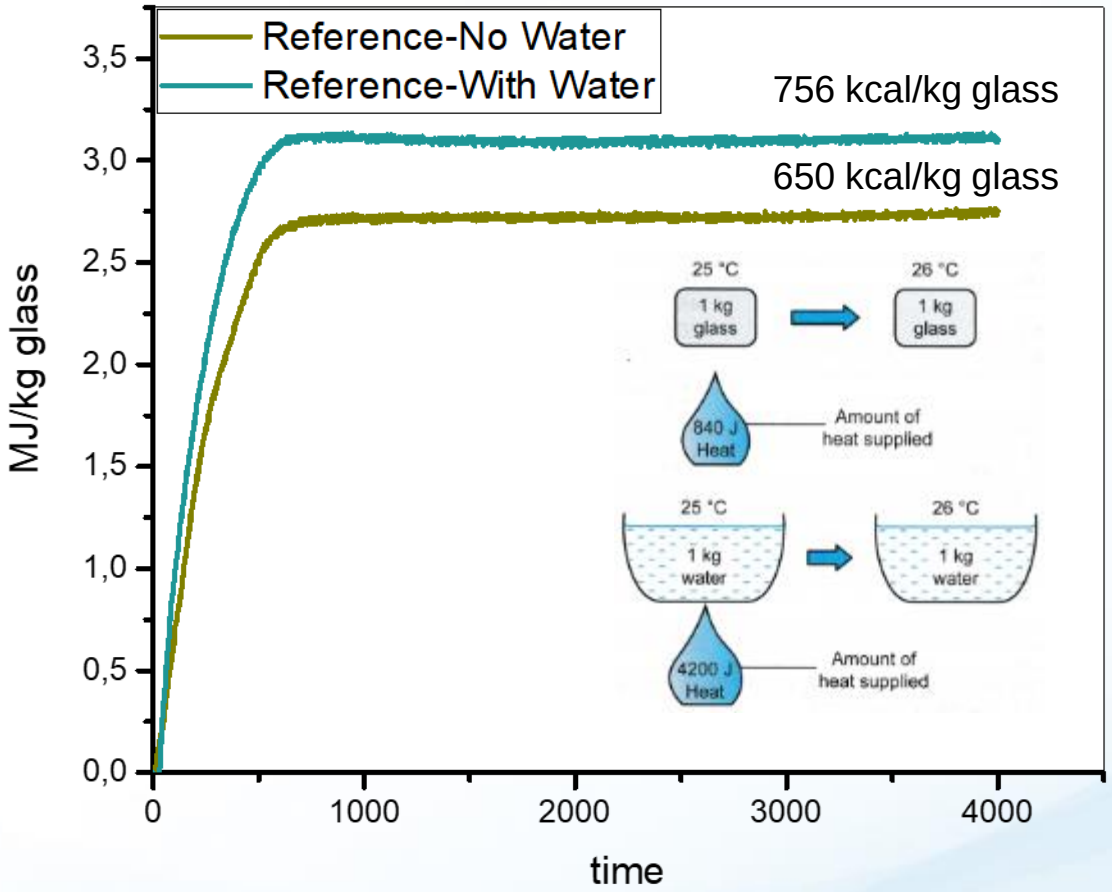
Bubble free time experiment

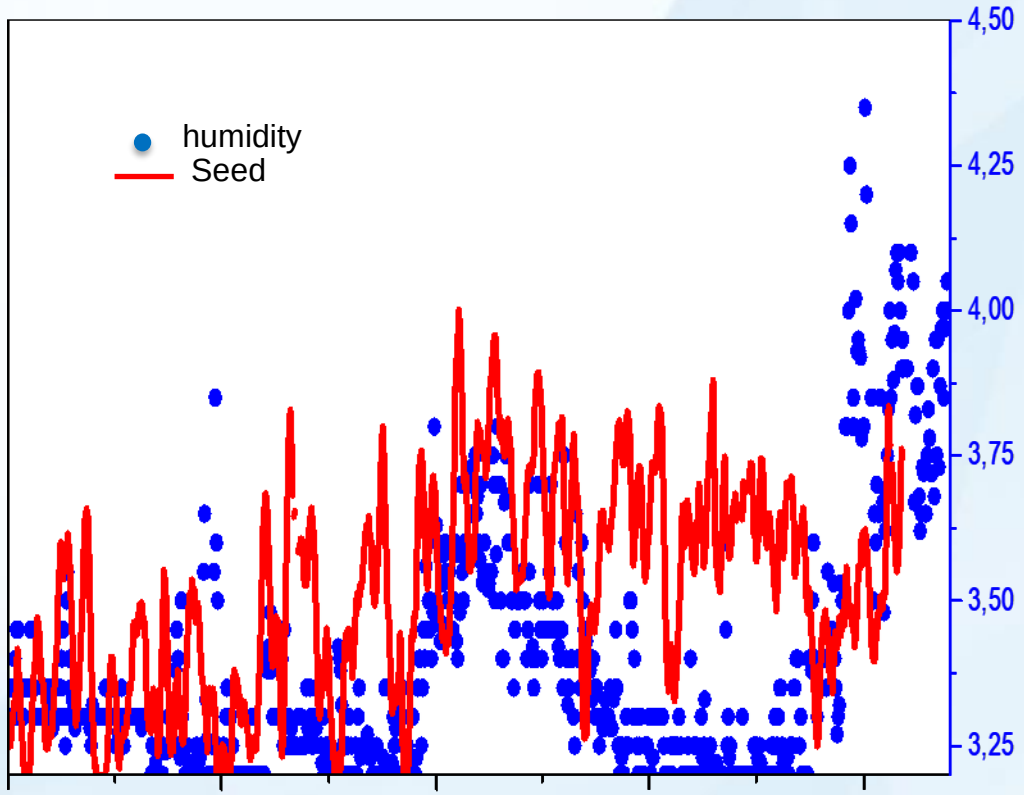


Better fining

Analysis methods

Example 3: Humidity





Sustainability in raw materials

Example 1: Decarbonated raw materials

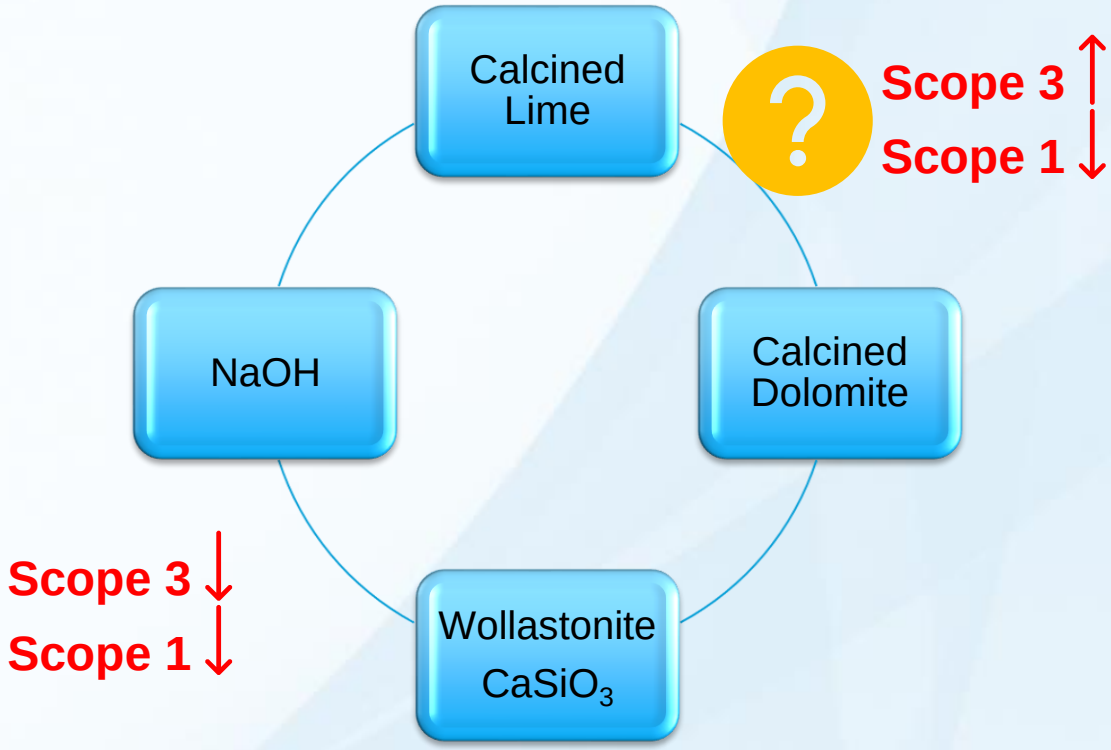
Container glass compositions;

	SiO2	Al2O3	CaO	MgO	Na2O
%wt.	71	1,65	9,8	3,3	13,3

$$CaCO_3 \rightarrow CaO + \cancel{CO_2}$$

$$CaMg(CO_3)_2 \rightarrow CaO + MgO + \cancel{CO_2}$$

$$Na_2CO_3 \rightarrow Na_2O + \cancel{CO_2}$$



5 Different Batches
Batch-1: Reference Batch (limestone + dolomite + soda ash)
Batch-2: Calcined lime instead of limestone
Batch-3: Wollastonite instead of limestone
Batch-4: Calcined lime and calcined dolomite instead of limestone and dolomite
Batch-5: Calcined lime, calcined dolomite, NaOH (zero carbonates)

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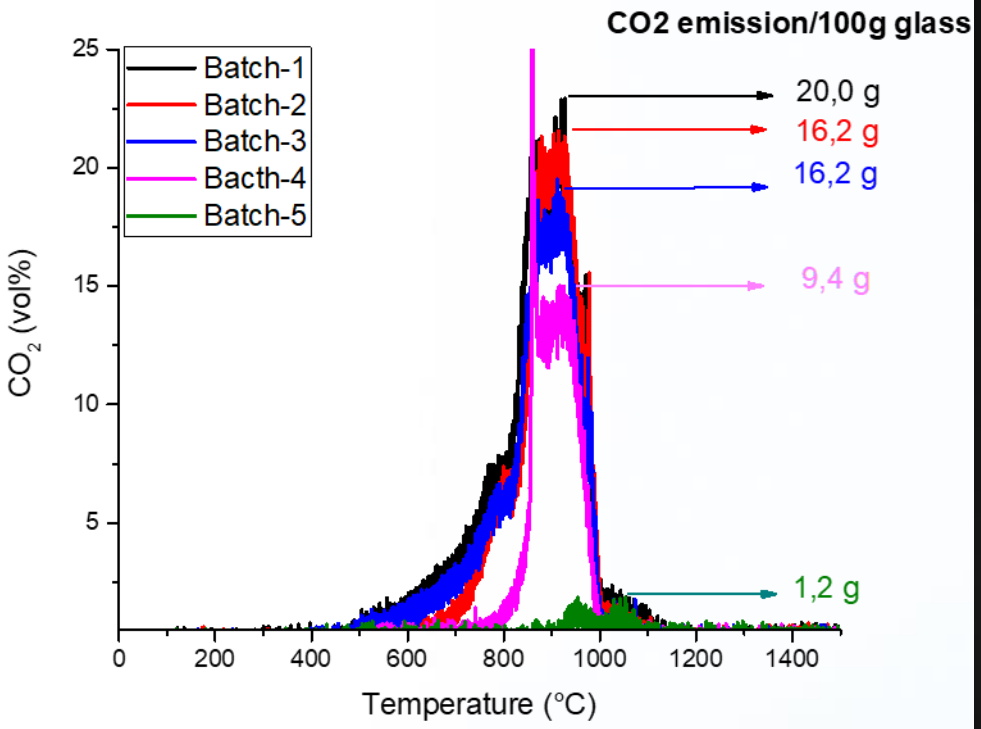
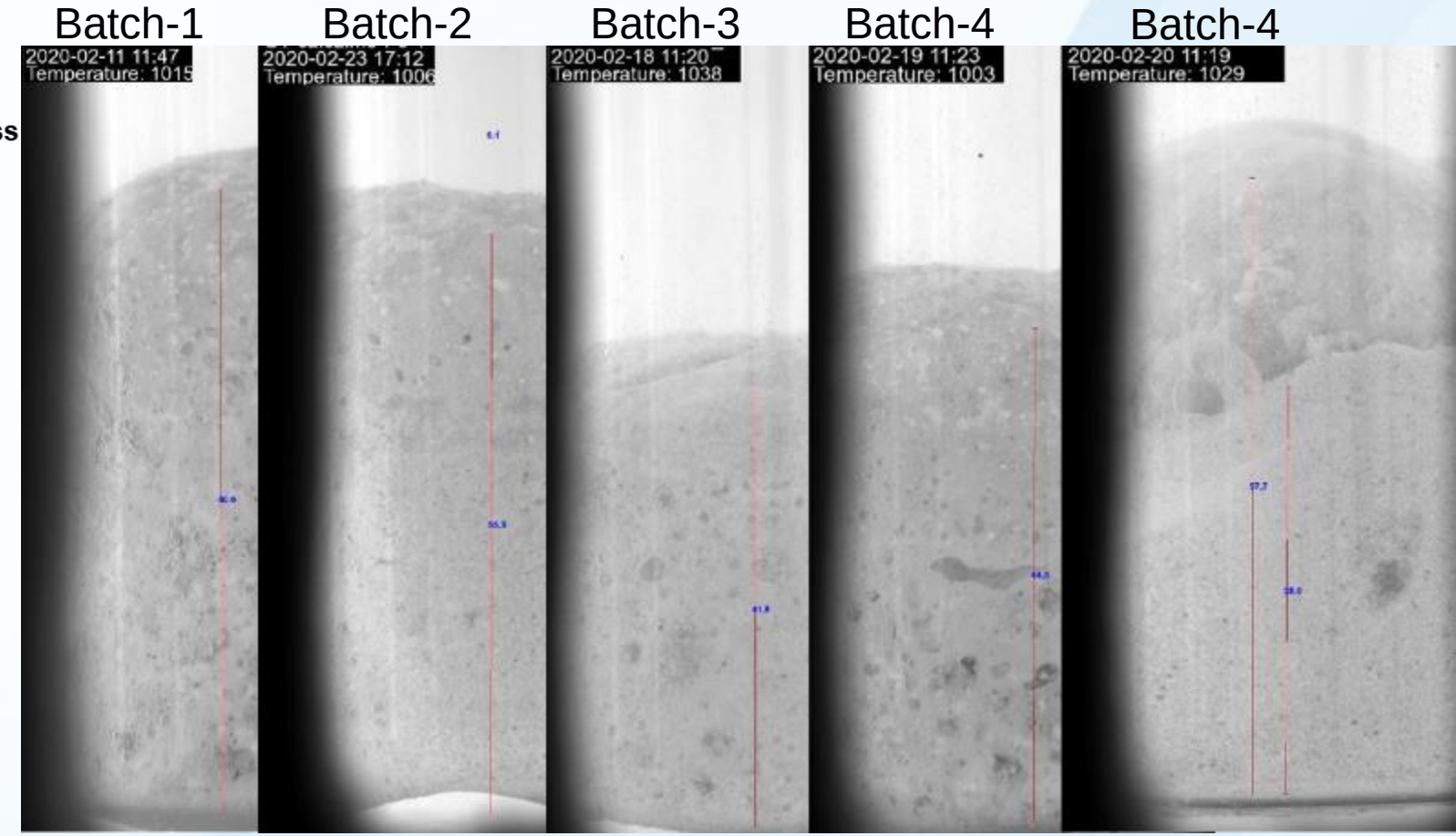
Sustainability in raw materials

Example 1: Decarbonated raw materials





✓ *%95 reduction achieved for container glass composition by varying raw materials in the batch*

Sustainability in raw materials

Example 2: Cullet

- *Glass is a uniqe material that can be recycled eternally, while reducing natural raw material consuption, CO_2 foot prints and energy consumption*

Challenges;

- *Low return levels of cullet (depends on location)*
- *Colour sorting*
- *Loses of fine particles*
- *Orcanic/inorganic impurities*

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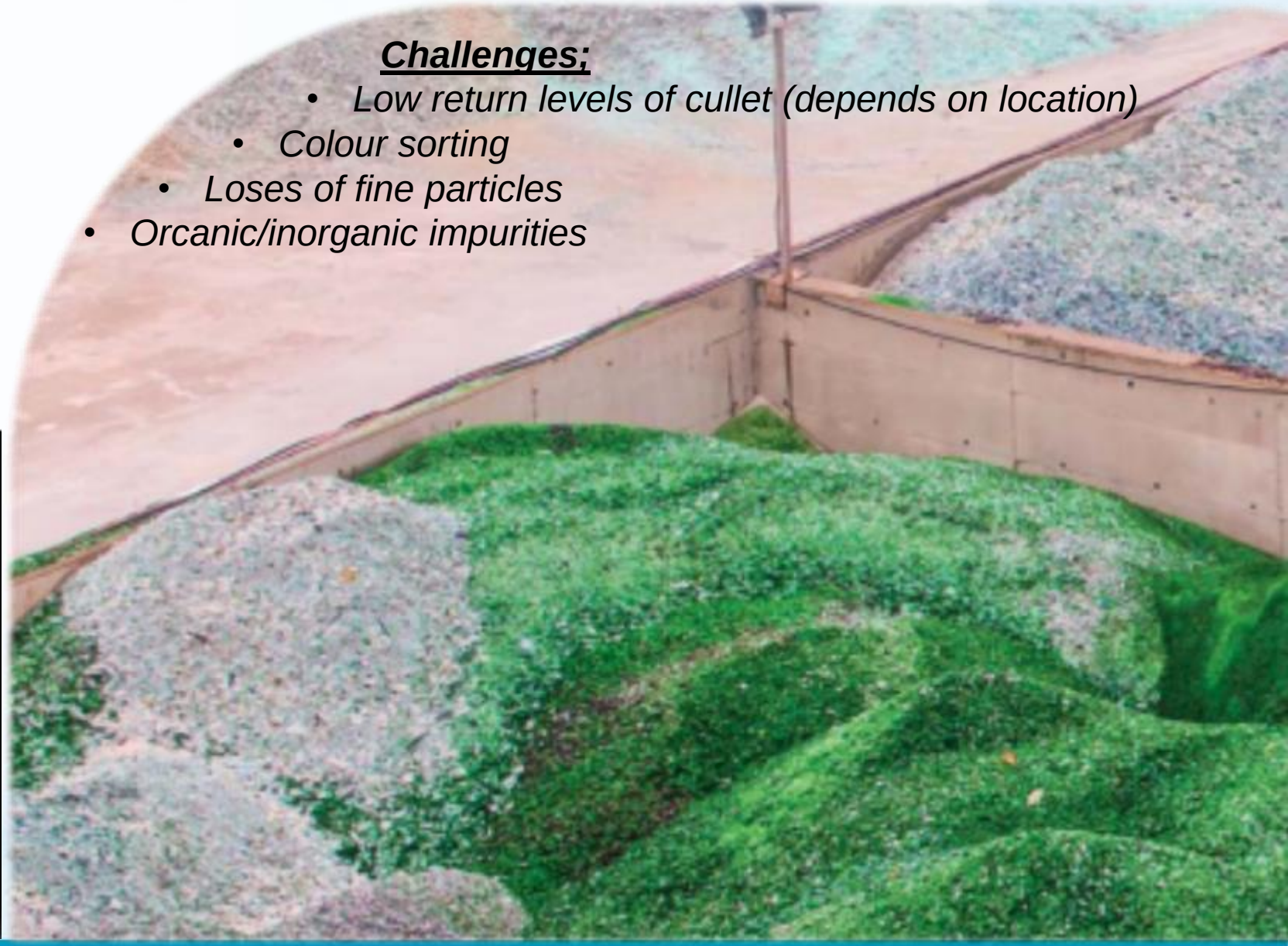
Sustainability in raw materials

Example 2: Cullet

Melting of cullet

Challenges;

- *Low return levels of cullet (depends on location)*
- *Colour sorting*
- *Loses of fine particles*
- *Orcanic/inorganic impurities*



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Glass is Sustainable: %100 Recycled Glassware

- Consumer perception change on glass colour by setting the anology with Bosphorous Turquoise. For color stability:
  - physical decolorizers were used,
  - recycled cullet ratio of different sources was adjusted acc.to Fe_2O_3 content
- Normally recyled glass is unclear and has bubbles. But not aware collection!

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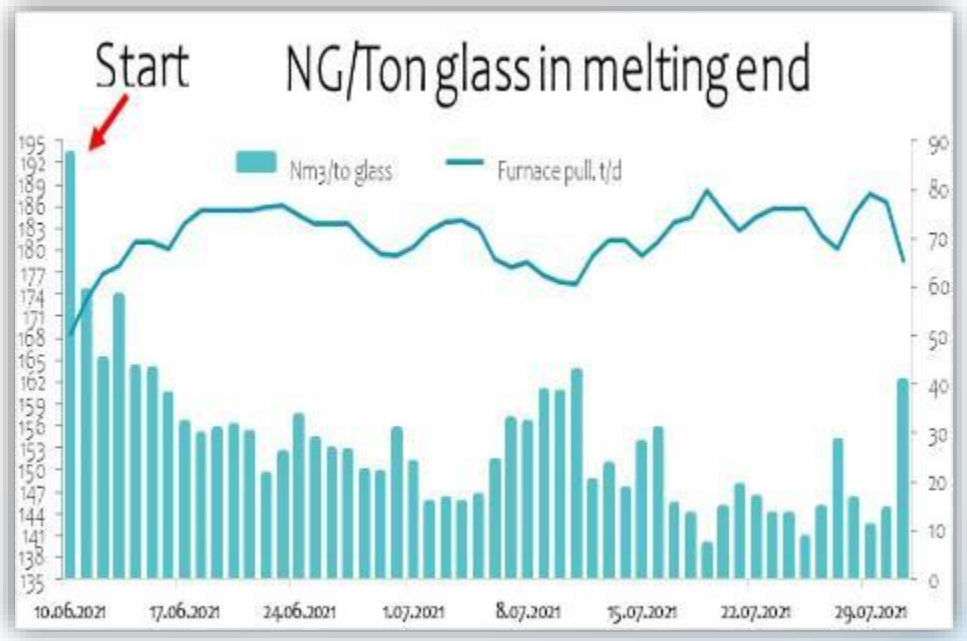
** Energy and emission values: according to 25% gc usage reference*

Glass is Sustainable: %100 Recycled Glassware



- 38% reduction in CO2 emissions was achieved, as well as energy saving of 31%.*

- Consumer perception change on glass colour by setting the anology with Bosphorous Turquoise. For color stability:
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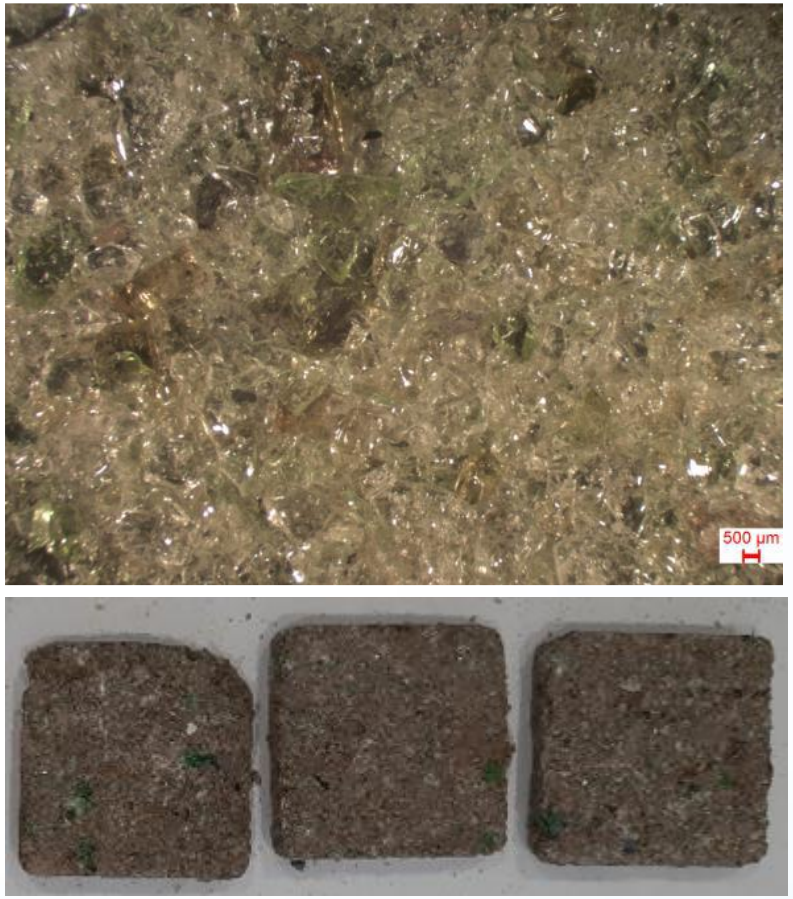
* *Patent application filed.*

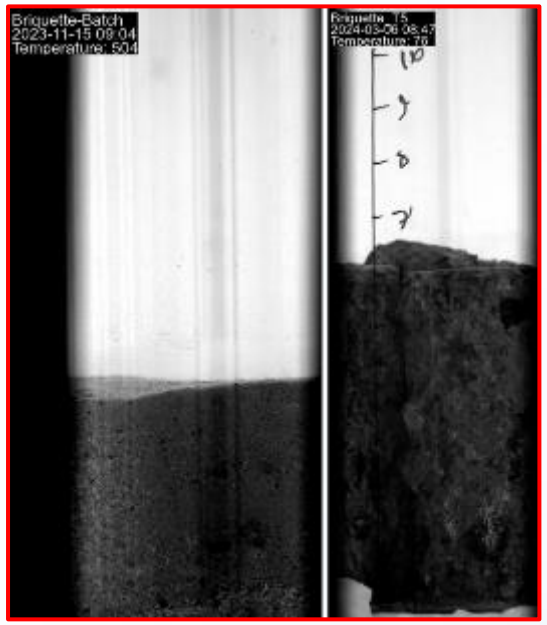
* *Energy and emission values: according to 25% gc usage reference*

Sustainability in raw materials

Example 3: Briquetting



Briquetting of land fill cullet one of the prior topic in melting kinetics



Initial stage of melting

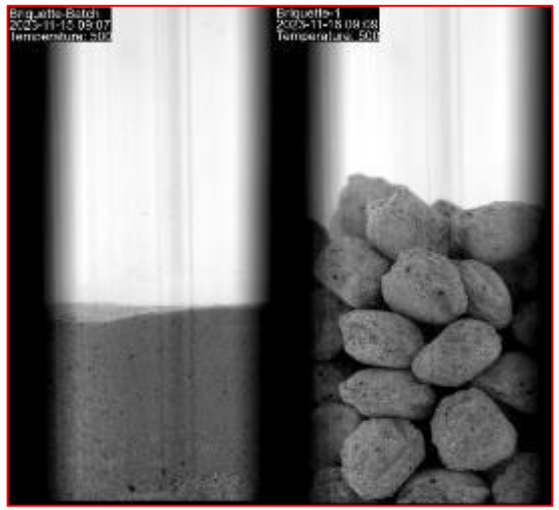
Early melt formation

Faster bubble removal

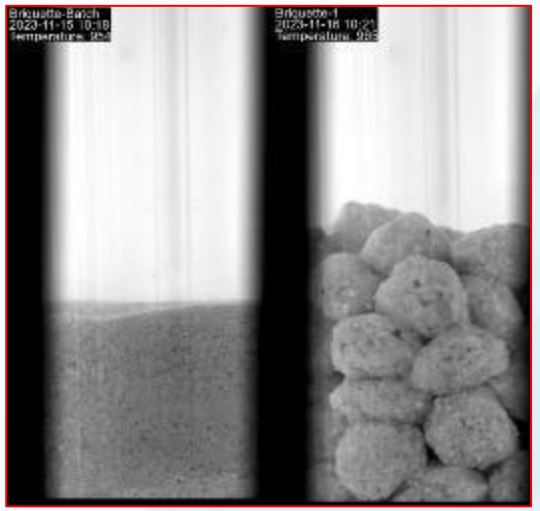
Sustainability in raw materials

Example 3: Briquetting

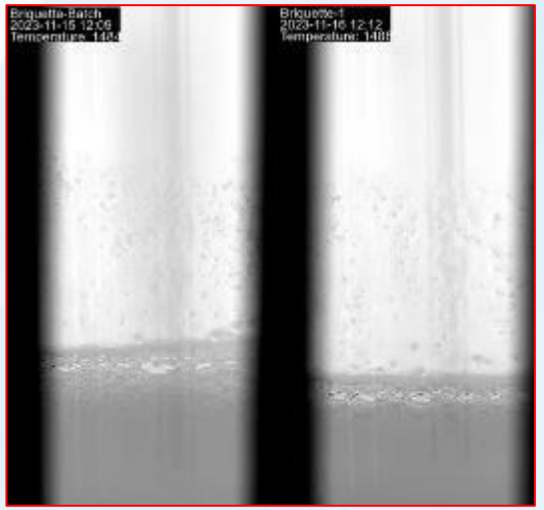
Briquetting of glass making raw materials one of the prior topic in melting kinetics



Initial stage of melting



Early melt formation



Faster bubble removal

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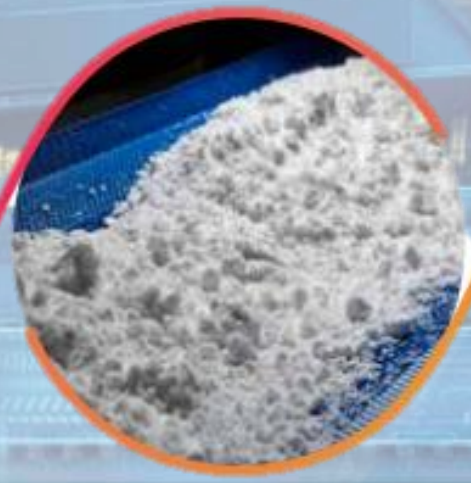


	EUROPE	WORLD	
FLAT GLASS	#2	#5	
GLASSWARE	#2	#2	
GLASS PACKAGING	#5	#5	
SODA	#4	#2	
AUTO GLASS*	#4	#8	

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- Since 1976
- 9600m² area
- 31 well equipped laboratories
- 250 employees

- ***GLASS TECHNOLOGIES***
- ***MELTING TECHNOLOGIES and ENGINEERING***
- ***SURFACE and COATINGS***
- ***MATERIAL SCIENCE and CHARACTERIZATION***
- ***INNOVATION, KNOWLEDGE and QUALITY MANAGEMENT***
- ***DESIGN CENTER***

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RECAP

- *Glass melting is energy intensive process and produces ~95 million tonnes of CO2 annually*

- *In order to meet the climate protection targets; radical improvements should be made within the industry*

- *Raw materials related CO2 emissions accounts approximately one third of the process emissions and there is a great improvement potential via batching solutions;*
  - *Better control on raw materials increases efficiency and quality*
  - *Use of analytical tools and equipments to investigate and implement improvements*
  - *Decrease CO2 emissions directly by shifting to decarbonated raw materials*
  - *Higher cullet consumptions will reduce CO2 emissions and improves melting*
  - *Batch & composition solutions to improve melting kinetics to use less energy*

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THANK YOU
FOR YOUR ATTENTION..
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Glass for a sustainable future
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