REFRACTORY MATERIALS CHALLENGES IN SODALIME GLASS FEEDERS

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GLASS, ALL TYPE OF GLASS, ONLY GLASS

Container glass
- Bottles
- Tableware
- Pressed glass
- Industrial container

Flat glass
- Float glass
- Drawn glass

E-glass
- LCD
- PDP Displays

Special glass
- Hollow glassware
- Pharmaceutical glass
- Crystal glass
- Lighting glass
- Heat-resistant glass
- Opal glass
- Enamel glass
- Vitroceramic glass

Wool fiberglass
- Insulation glass

Reinforcement fiberglass

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- **Feeder : deliver glass to the spout**

  right **temperature** (viscosity)

  high **homogeneity** and **stability** (temperature, composition..)

  allow adaptation / **flexibility** with fast response time

  high **energy efficiency**

- **Feeder refractories**

  No contamination for suitable **glass quality**

  Stable performance thru the entire **campaign life**

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SUPERSTRUCTURE

GLASS CONTACT

Optimized selection ?

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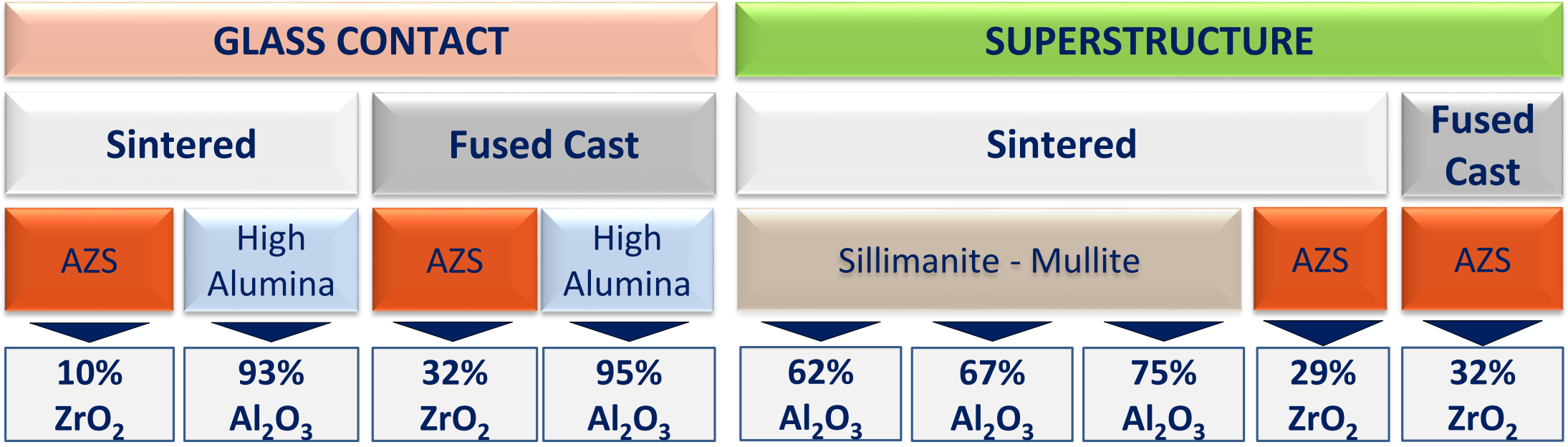
REFRACTORY CHOICE & CONSTRAINTS

	What is **at stake ?**	**Refractory requirements**
GLASS CONTACT	**No Glass Contamination** **Campaign Life**	- **Corrosion resistance** - **Low glass defects** - **Larger shape -** to reduce joints
GLASS CONTACT	**Glass temperature** **and homogeneity**	- **Thermal conductivity**
SUPER-STRUCTURE	**Campaign Life** **No Glass Contamination**	- **Vapour corrosion** resistance - Thermo-mechanical behaviour : **creeping**
SUPER-STRUCTURE	**Temperature homogeneity**	- **Complex shape** (design)
SUPER-STRUCTURE	**Pull rate** change and **quick response**	- **Thermal cycling**, **thermal shock** resistance

REFRACTORY MATERIALS FAMILIES



Based on the **glass requirement** (size, temperature, quality, …)
Geographic choices / **habits** observed.

Perfectly fit requirements in most **container glass production**.

Address **particular cases**

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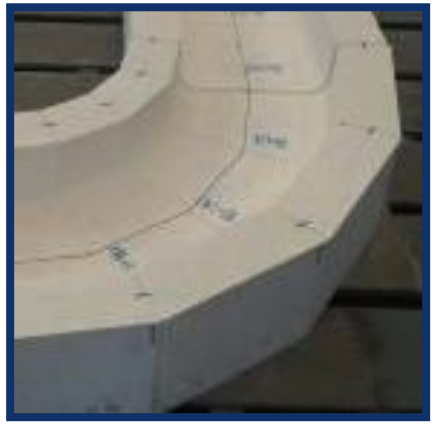

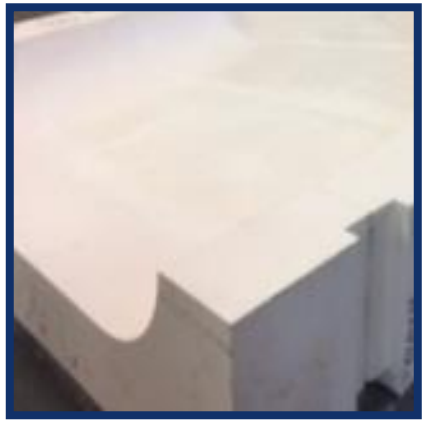

GLASS CONTACT

Corrosion, Glass defects

Refractory material choice

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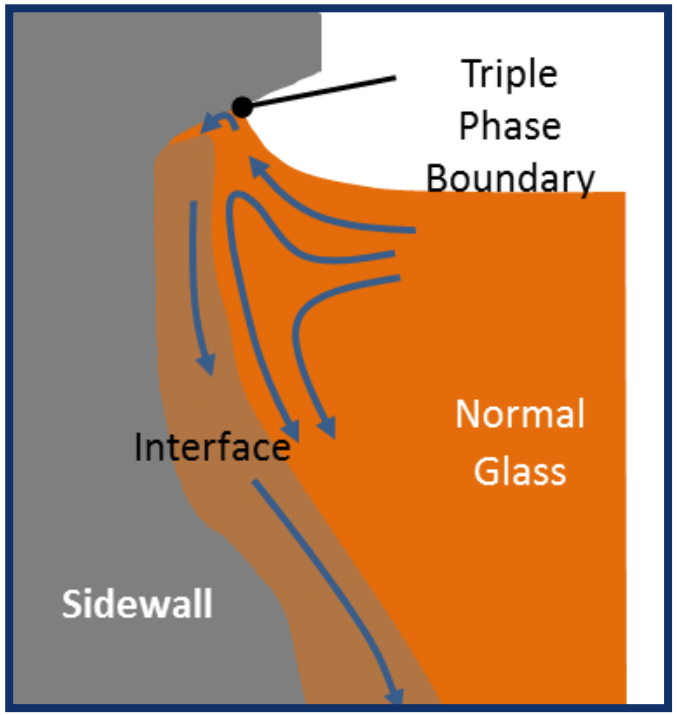
GLASS CONTACT - CORROSION

- **Metal line corrosion : Marangoni effect**

  Temperature / Refractory composition / Flow rate



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GLASS CONTACT - CORROSION

- **Joint corrosion**

  Glass composition / Glass infiltration / Upwardrilling process

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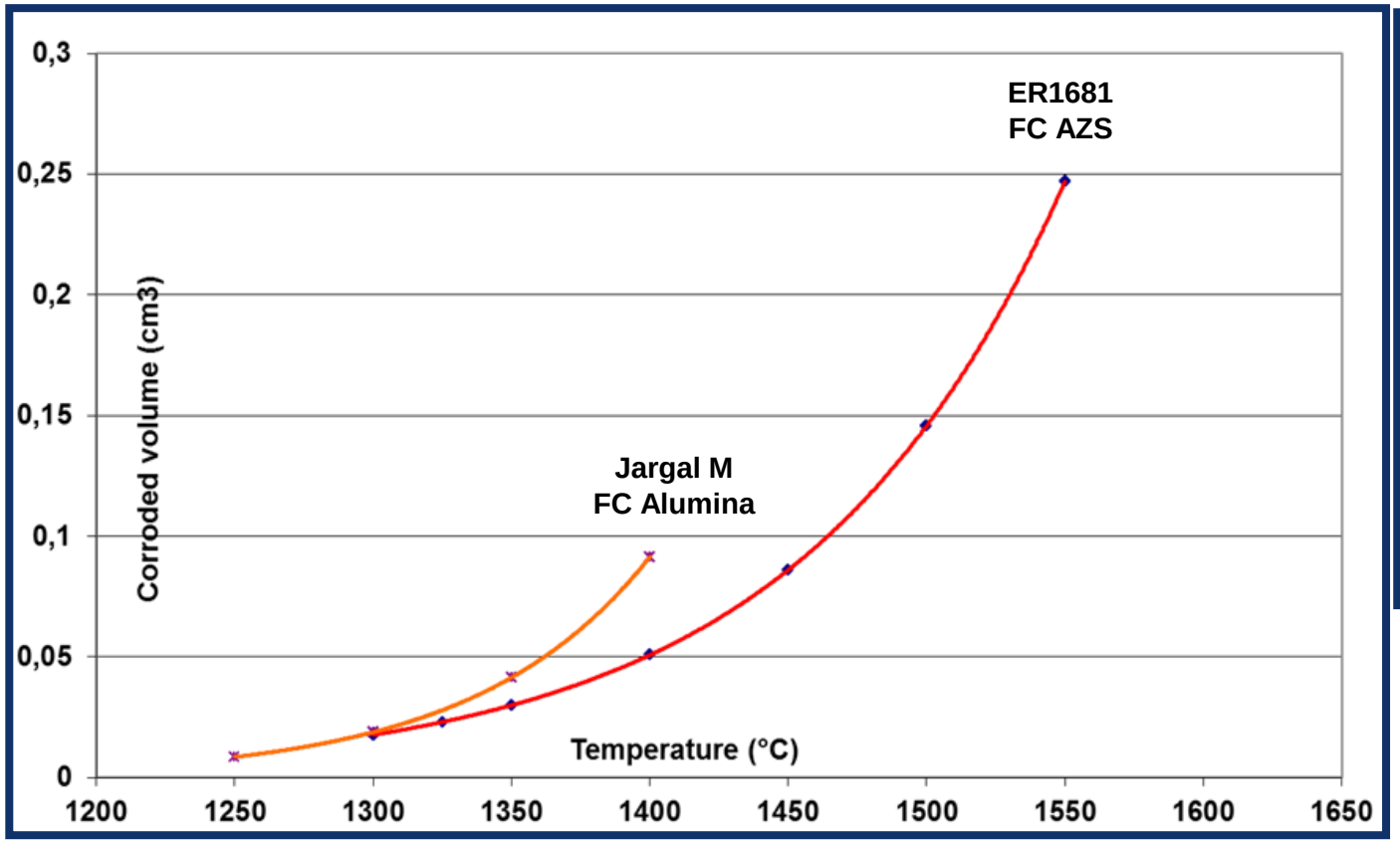
GLASS CONTACT - CORROSION

- **Temperature impact**
  - Highly temperature sensitive
  - FC AZS recommended for T > 1350°C



T°C ≤ 1300 °C

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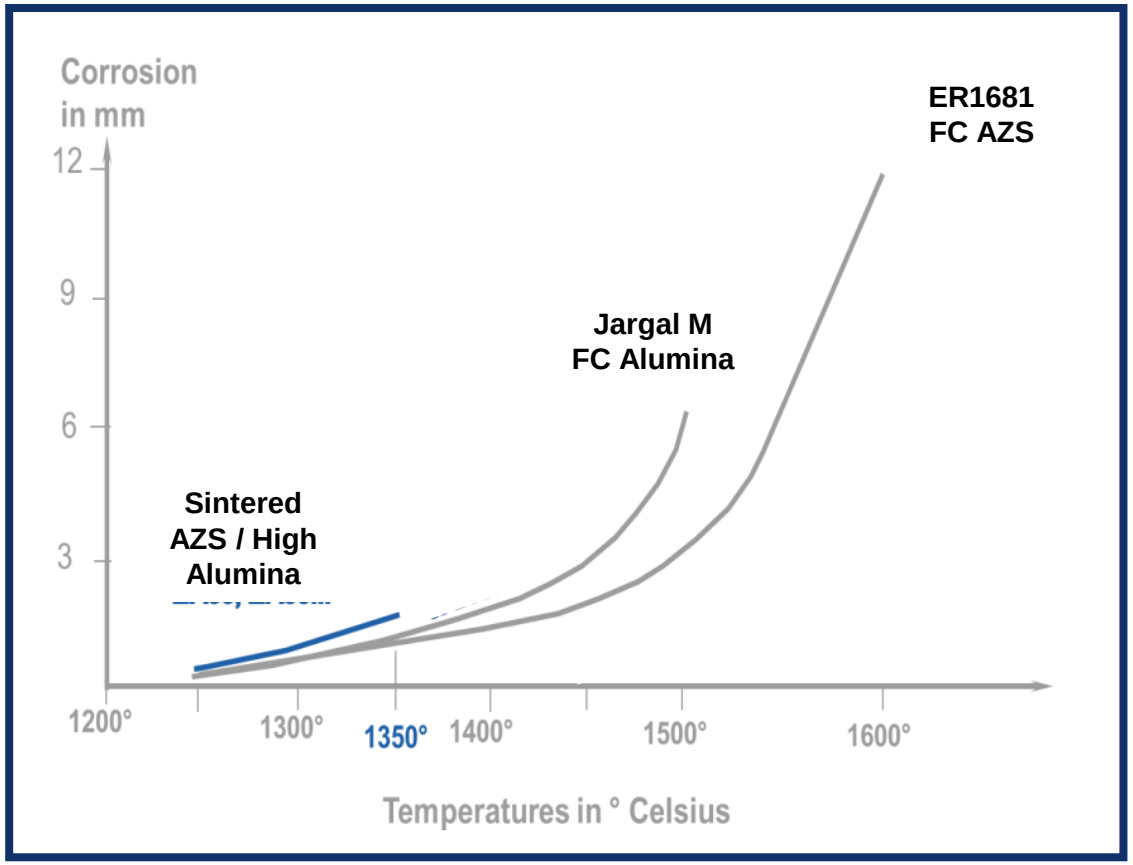
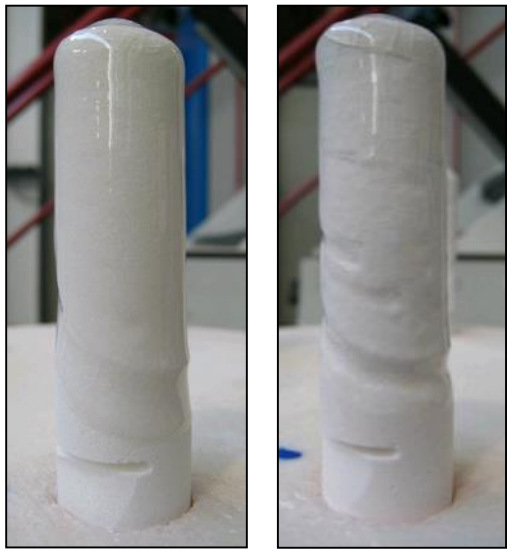
GLASS CONTACT - CORROSION

- At temperature < 1200°C => fused and sintered have similar corrosion rate



T° 1300 °C, 170 hrs at 6 rpm



Differences **< 10%**

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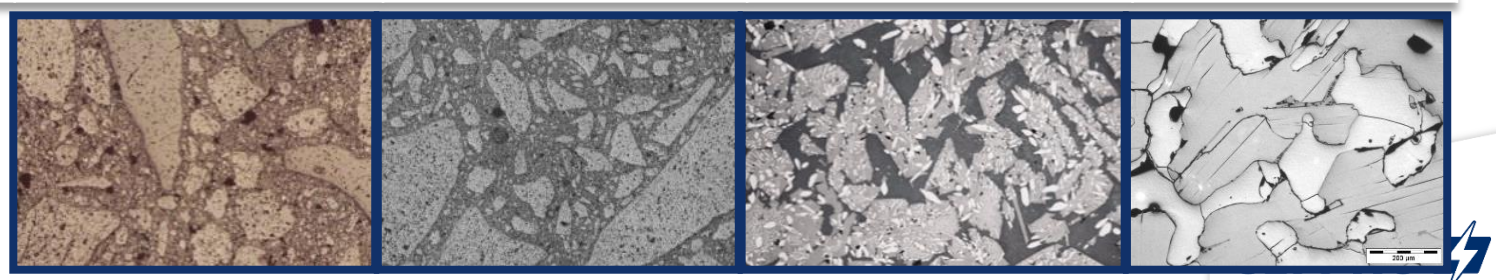
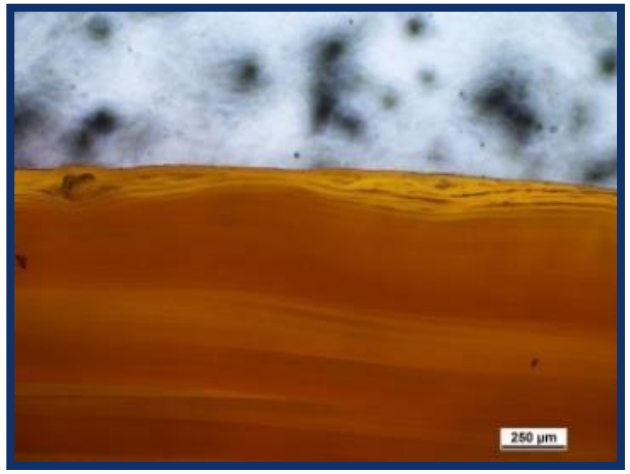
GLASS CONTACT - CORROSION SYNTHESIS

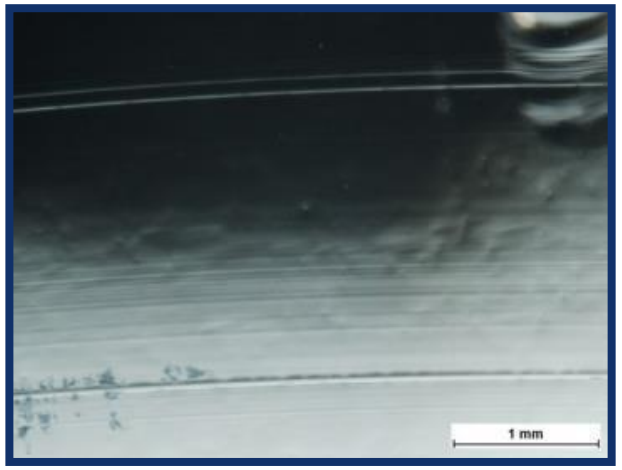
		Sintered AZS ZA33	Sintered Alumina BPAL	FC AZS ER1681	FC Alumina Jargal M
Chemical analysis	ZrO_2	10%	/	32%	/
	Al_2O_3	76%	93%	51%	95%
	SiO_2	12%	6%	15%	0,8%
Physical properties	Apparent porosity	16%	14%	2%	3%
Corrosion Index	1250°C	Similar			
	1350°C	90	80	120	100



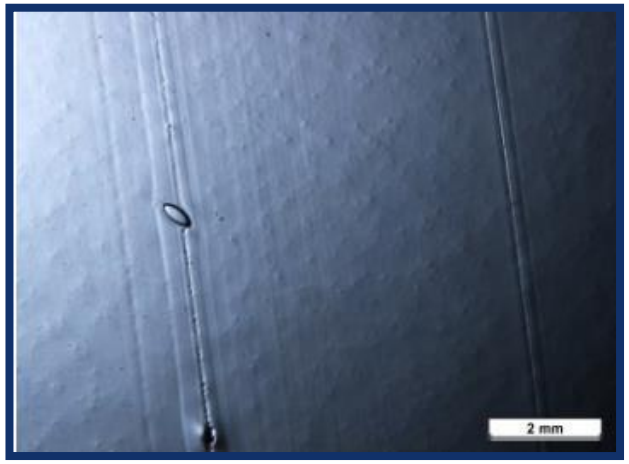
GLASS CONTACT – CAT SCRATCHES

- Heterogeneous glassy band on glass surface (5 to 40 µm typical)





Main origin: glass contact refractory



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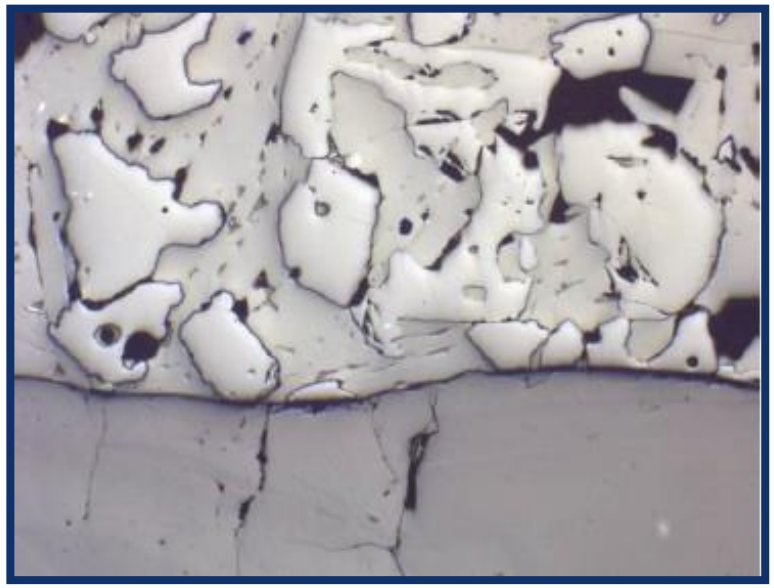
GLASS CONTACT – CAT SCRATCHES

FC AZS
ER1681

Interface layer:
- Dissolved corundum
- Residual ZrO_2 crystals

FC Alumina
Jargal M



No crystals released.
Only enrichment in alumina

- Defects analysis allows to identify the **material origin (Al/Zr ratio)**
- High **Alumina** based refractories generates **less defects**

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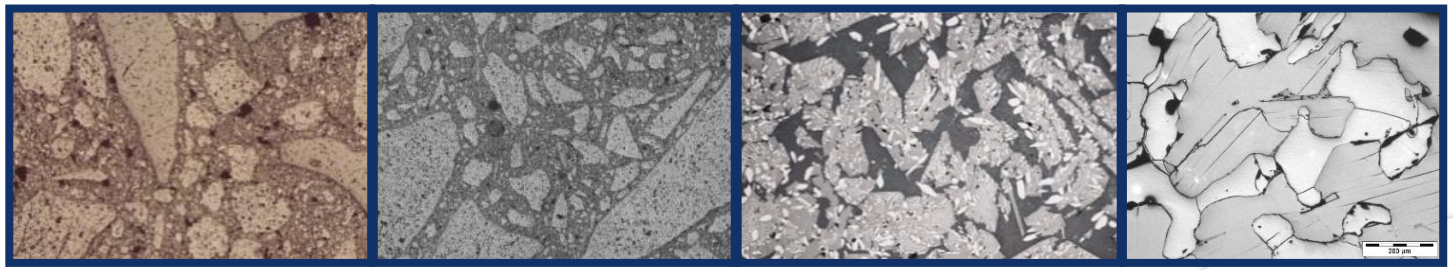
	SiO_2	12%	6%	15%	0,8%
Physical properties	Apparent porosity	16%	14%	2%	3%
	Cat scratches risk	+	0	+	00



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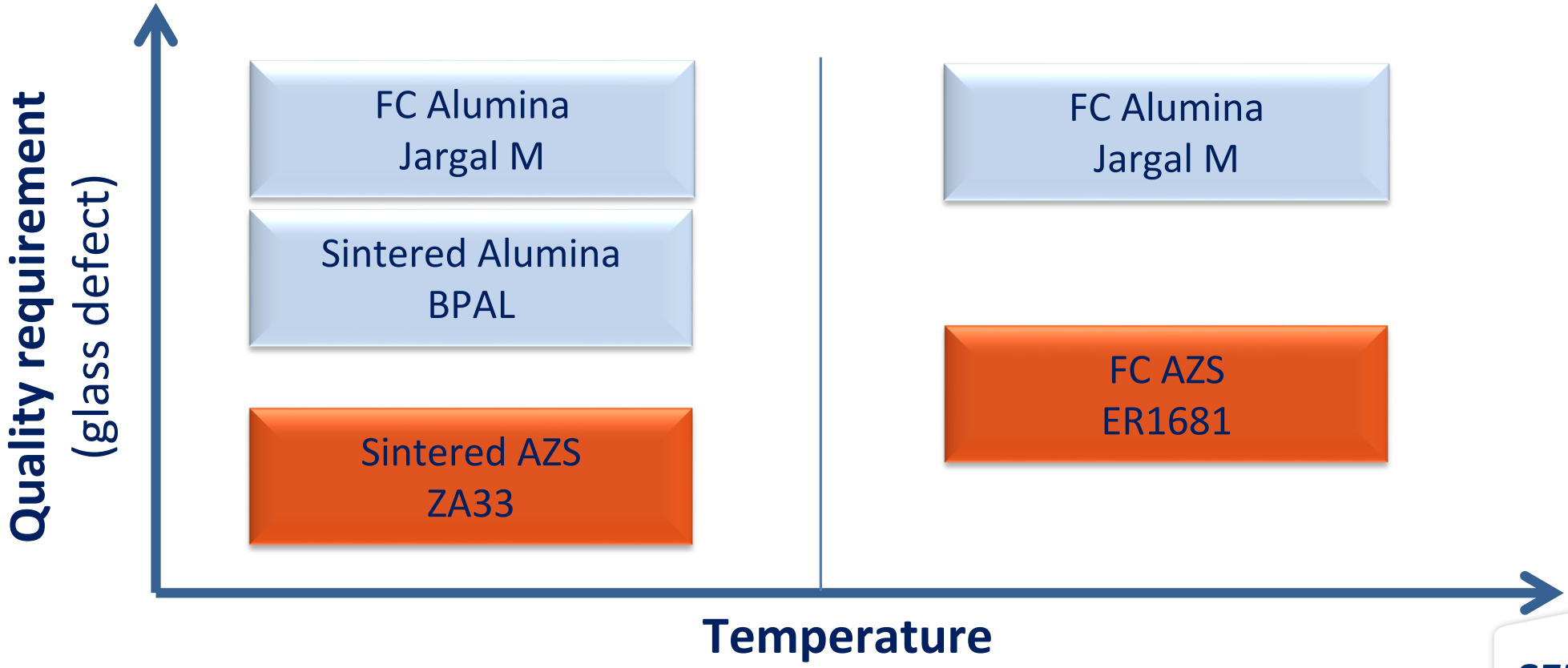
GLASS CONTACT – SUMMARY REFRACTORY CHOICE

Materials selection depends on **Temperature** (lifetime) and **glass quality** expectation



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SUPERSTRUCTURE

Creep & Vapour corrosion

Refractory material choice

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SUPERSTUCTURE – INDUSTRIAL SITUATION

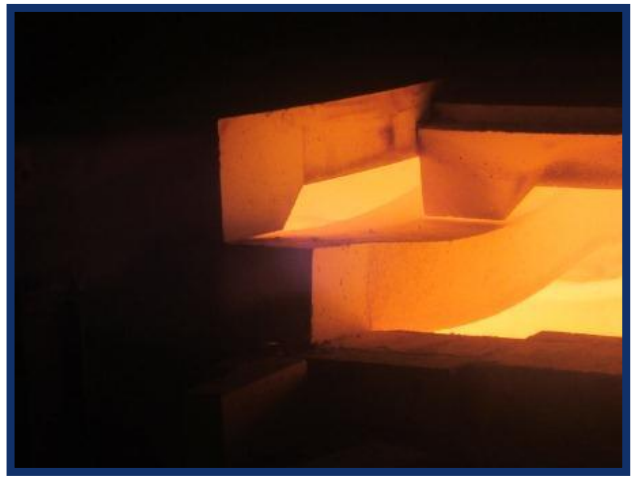
- **Vapor corrosion**

  Diffusion, interface layer formation

  Spalling, dripping

- **Creeping**

  Block deformation, refractoriness



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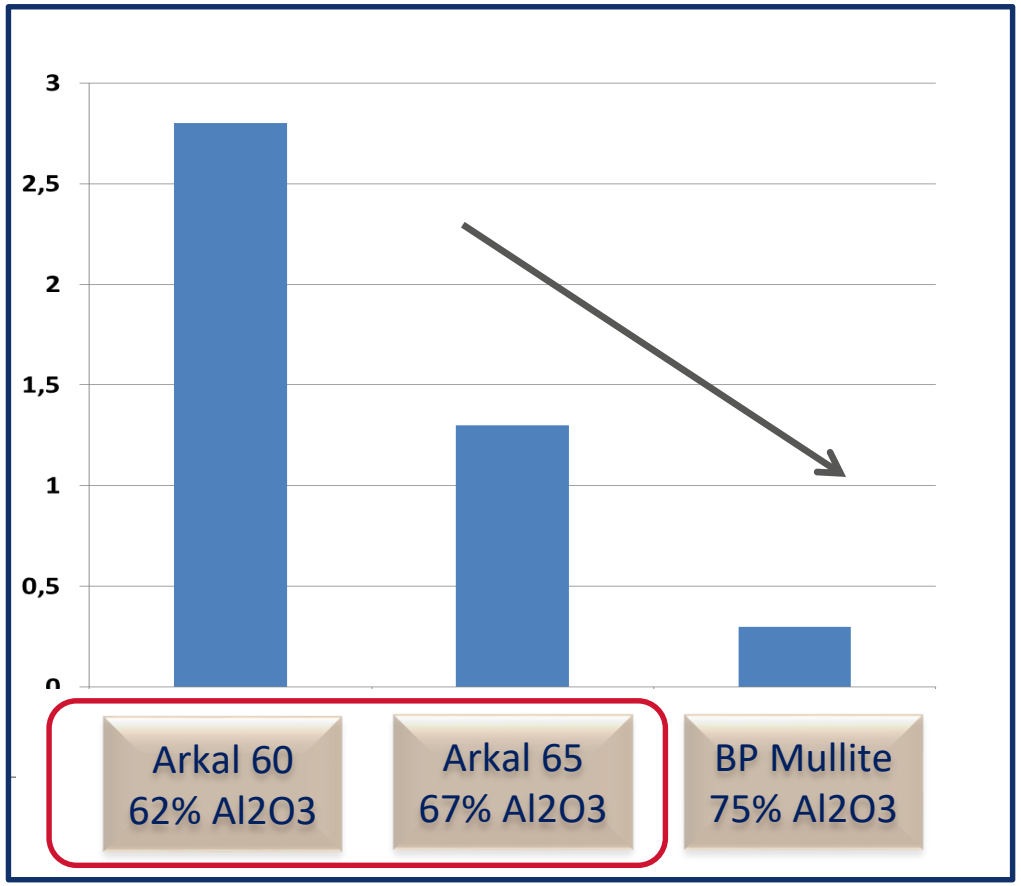
SUPERSTUCTURE – CREEP

	Sillimanite - Mullite			Sintered AZS	
	Arkal 60	Arkal 65	BP Mullite	Promold	Ziral
Al2O3 weight %	**62**	**67**	**75**	53	70
SiO2 weight%	34	29	24	16	10
ZrO2 weight %	/	/	/	**28**	**19**
Density (g/cm3)	2,50	2,60	2,70	3,25	3,15
Open Porosity %	17	15	15	11	17
Thermal Expansion (ppm/°C)	5,4	5,5	5,4	6,1	5
Thermal conductivity (W/mK)	2	1,7	1,8	2,7	2,0
Cold crushing (Mpa)	80	120	100	220	50
RUL @ **0.2 MPa**	1540°C	1580°C	>1700°C	>1660°C	1650°C

- Mainly using **Sillimanite – Mullite,** compatible with **complex** and **large shape**

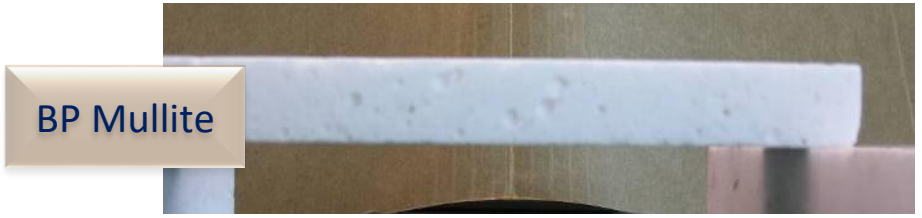
SUPERSTUCTURE – CREEP

Total Creep 1450°C, 100 hrs, 2 bars



1450°C: high temperature

Sillimanite, 62% Al_2O_3

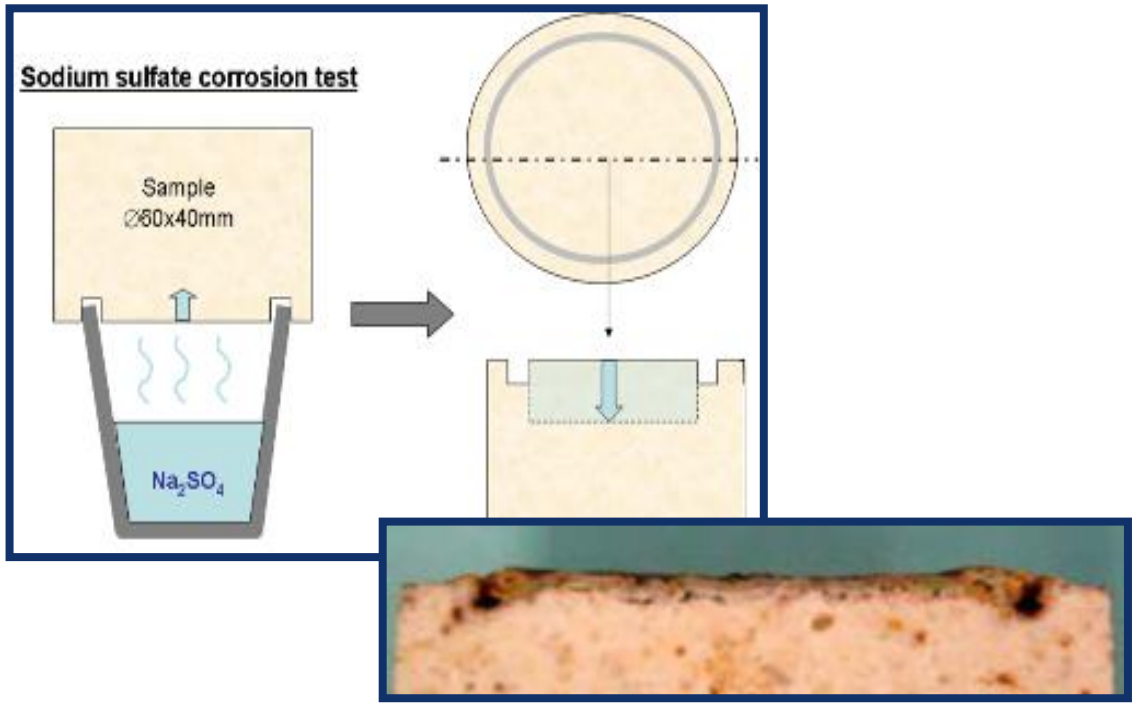


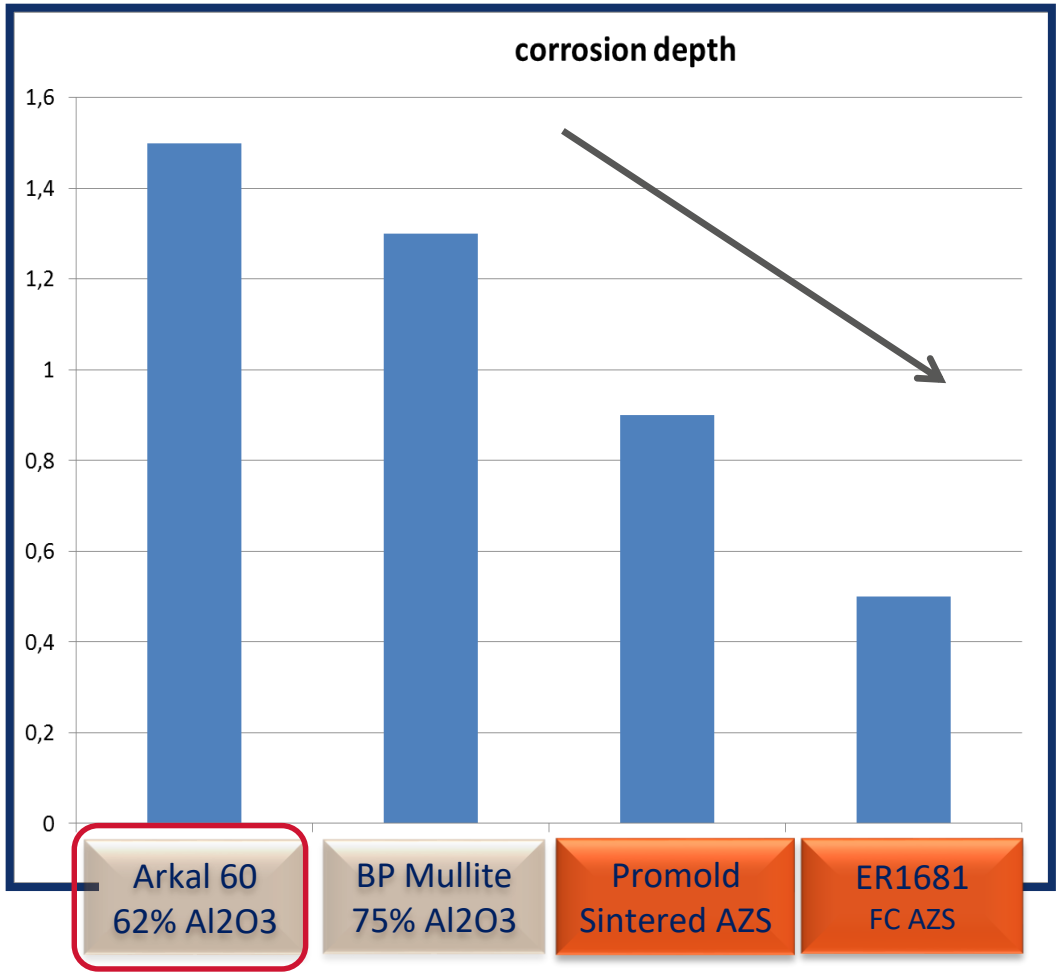
Sintered Mullite 75% Al_2O_3

- Mainly using **Sillimanite – Mullite**, critical criteria : couple **Temperature** of use / **Span**
- Creep resistance increases with **Al_2O_3 content** and Mullite content

SUPERSTUCTURE – VAPOR CORROSION

Na_2SO_4 vapors test : 100 h / 1400°C





- **AZS** material for **high corrosion** area
  - **Promold / Ziral** : coloring feeder or extra white (high Na vapor)
  - **(ZA33** : skimmer and glass contact)

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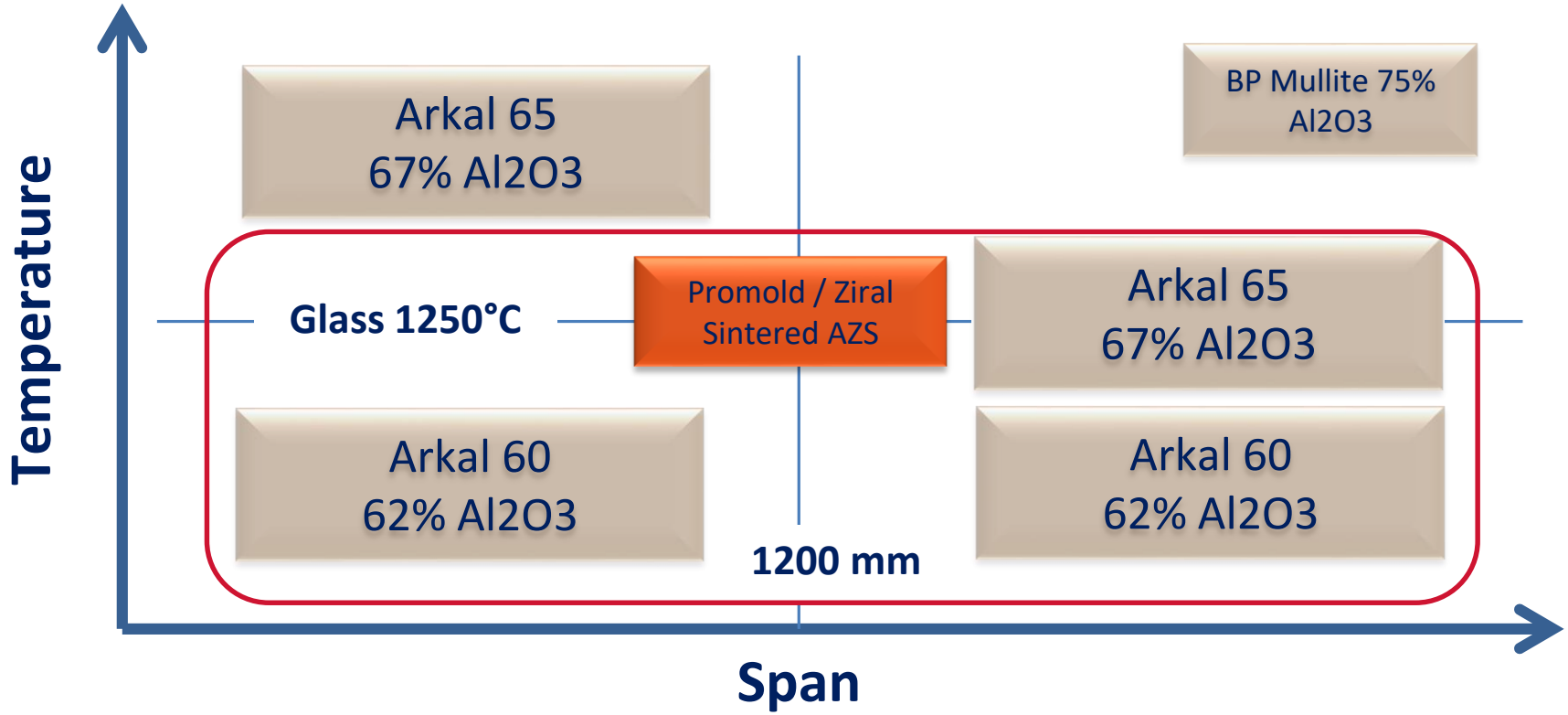
SUPERSTUCTURE – SUMMARY REFRACTORY CHOICE

Mainly **Arkal : Thermo-mechanical** parameter (temperature of use / span)
Promold / Ziral for **coloring feeder / thermal shock area**



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CONCLUSIONS

SUPERSTRUCTURE

GLASS CONTACT

Optimized selection ?

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CONCLUSIONS

SUPERSTRUCTURE

GLASS CONTACT

Life Time (Temperature Span)
Localized corrosion

Glass Quality
Life Time (Temperature)

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CONCLUSIONS

SUPERSTRUCTURE

GLASS CONTACT

Life Time (Temperature Span)
Localized corrosion

Glass Quality
Life Time (Temperature)

A large range of choice

- Sintered or Fused cast
- Sillimanite – Mullite / Alumina / AZS

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CONCLUSIONS

SUPERSTRUCTURE → **Life Time (Temperature Span)**
Localized corrosion

GLASS CONTACT → **Glass Quality**
Life Time (Temperature)

A large range of choice

- Sintered or Fused cast
- Sillimanite – Mullite / Alumina / AZS

- Specification (joints, size, aspect, …)
- Reliability

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THANK YOU

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