DURANDAL RX:
A NEW REACTIVE REFRACTORY MATERIAL

X.Y. XIONG

Product Development and Application Manager

IMERYS REFRACTORY MINERALS

154/156, Rue de l'Université, F-75007 Paris, France

Mobile: +32-497448758

e-mail: xiaoyong.xiong@damrec.com

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PLAN OF PRESENTATION

-Objective

-Andalusite: characteristics

-Sinter Reactivity of DURANTAL RX in comparison with Reactive Alumina (RA)

-Substitution of Reactive Alumina by DURANTAL RX in castable

-Conclusions

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OBJECTIVE

1. Sinter Reactivity of DURANTAL RX in Comparison with Reactive Alumina
2. Application of DURANTAL RX in LCC and ULCC Castable Matrix: Creation of Ceramic Bonding of Mullite Nature, in Comparison with Reactive Alumina Matrix

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ANDALUSITE:

characteristics

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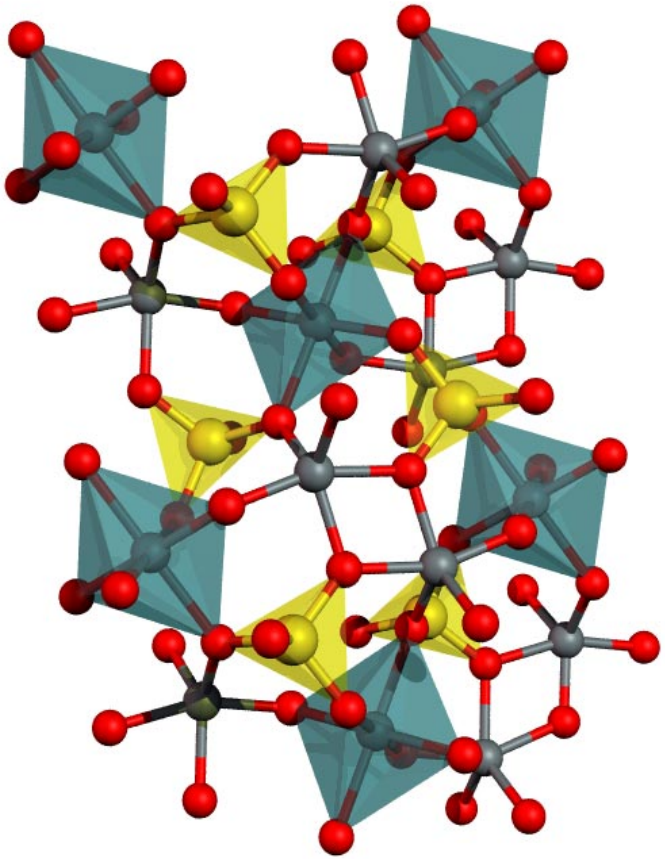
Andalusite Crystal Structure



Group :
alumina silicates with Kyanite and Sillimanite

Composition :
$Al_2O_3\,SiO_2$
(63% Al_2O_3, 37% SiO_2)

Density = 3.15, **Hardness** = 7.5

Crystalline system :
Orthorhombic

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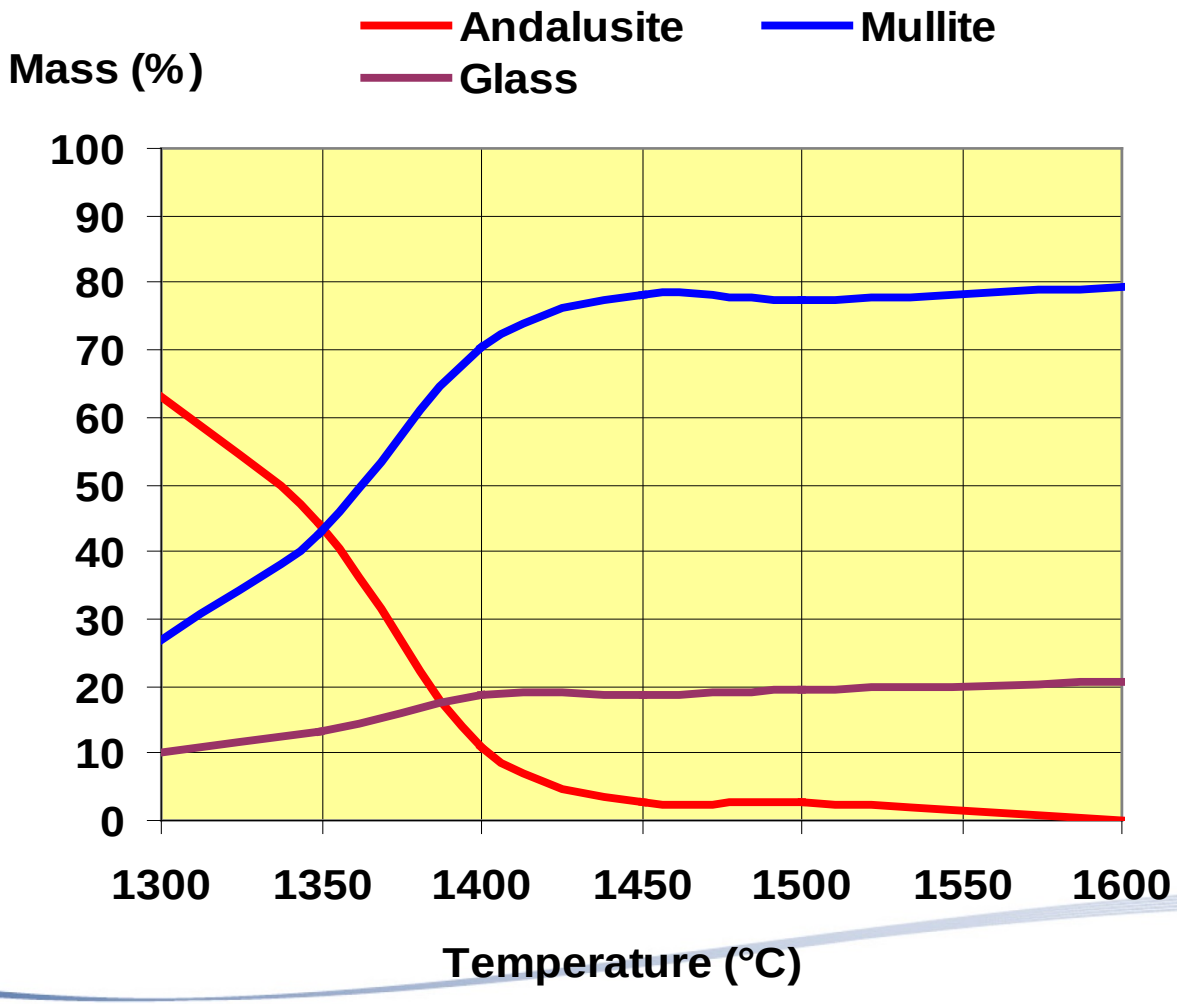
Andalusite transformation with temperature: Mullitisation

$$3(Al_2O_3.SiO_2) \rightarrow 3Al_2O_3.2SiO_2 + SiO_2$$
andalusite — mullite — glass



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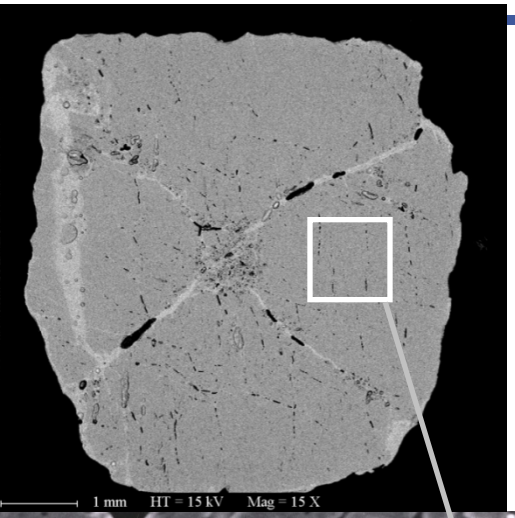
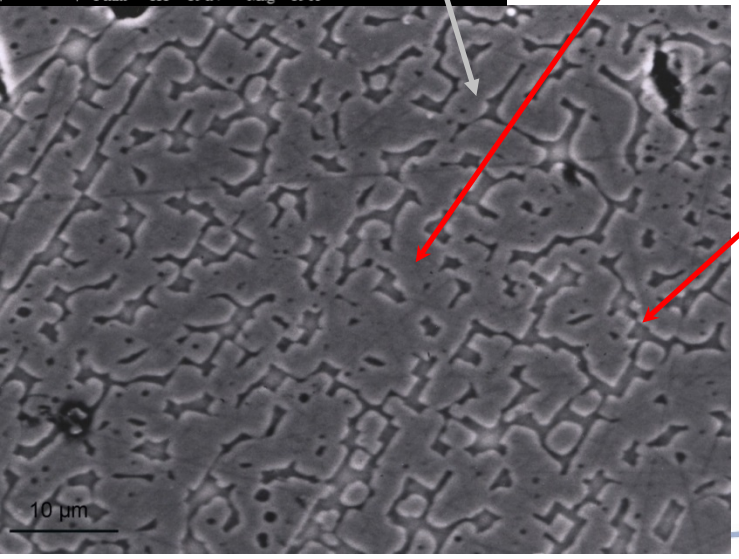
Microstructure of the mullitised andalusite (1550°C)

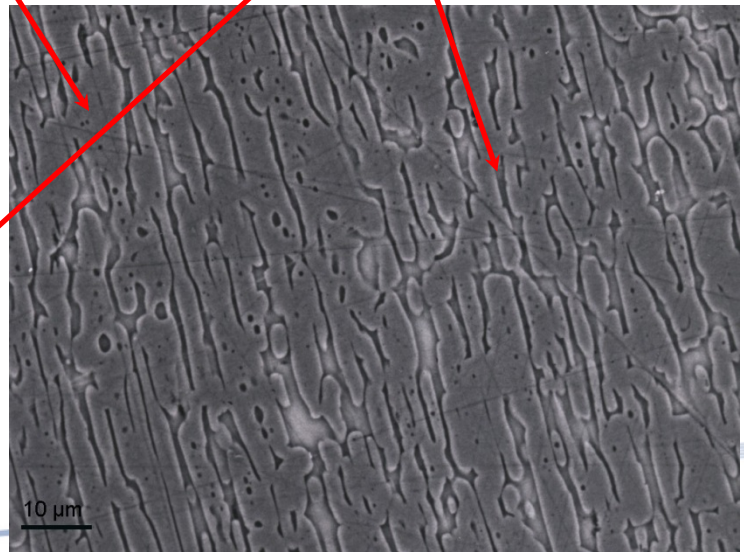
MULLITISED ANDALUSITE = MULLITE + GLASS COMPOSITE NETWORK



MULLITE

GLASS





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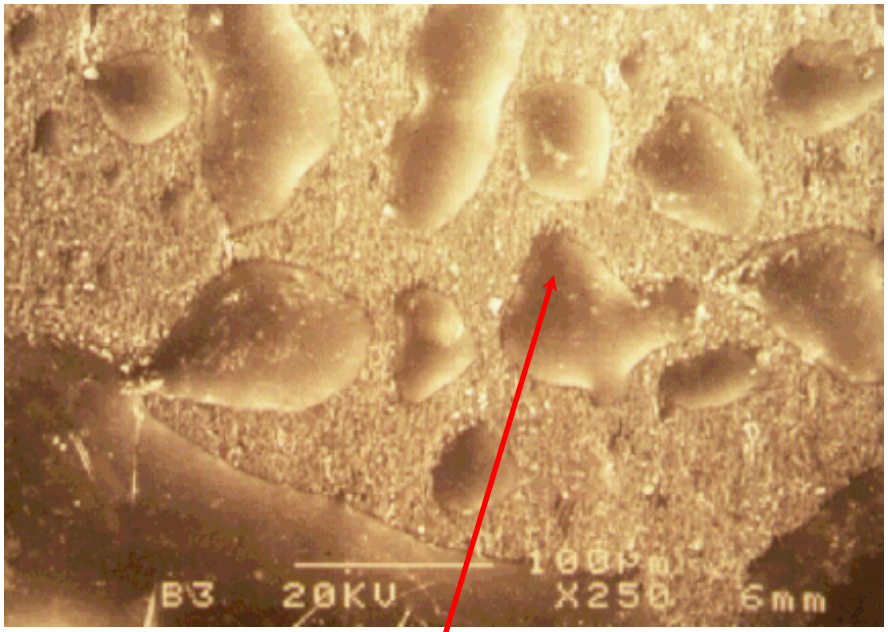
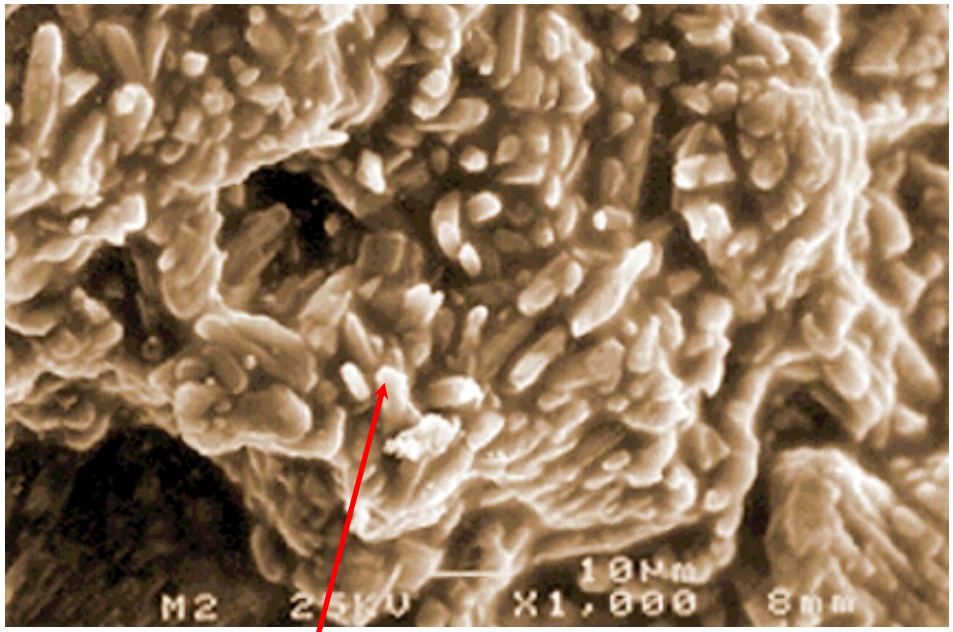
Glass react with alumina for forming a secondary mullite

$2SiO_2$ + $3Al_2O_3$ → $3Al_2O_3.2SiO_2$

glass alumina secondary mullite



Glass droplets



Secondary mullite crystals

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Main characteristics of Andalusite

High Refractoriness under load

High Resistance to thermal shock

High Creep resistance

Formation of ceramic binding since midlle temperature

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Sinter Reactivity of DURANTAL RX in comparison with Reactive Alumina (RA)

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Measure of reactivity:

-shrinkage after sinter

-cold module of rupture

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Chemical Composition of DURANTAL RX and Reactive Alumina

Chemical composition	**DURANTAL RX**	**Reactive Alumina (RA)**
Al_2O_3	**59,81**	**99,92**
SiO_2	**38,06**	0,02
Fe_2O_3	0,85	0,02
Na_2O	0,26	0,03
K_2O	0,28	0,00

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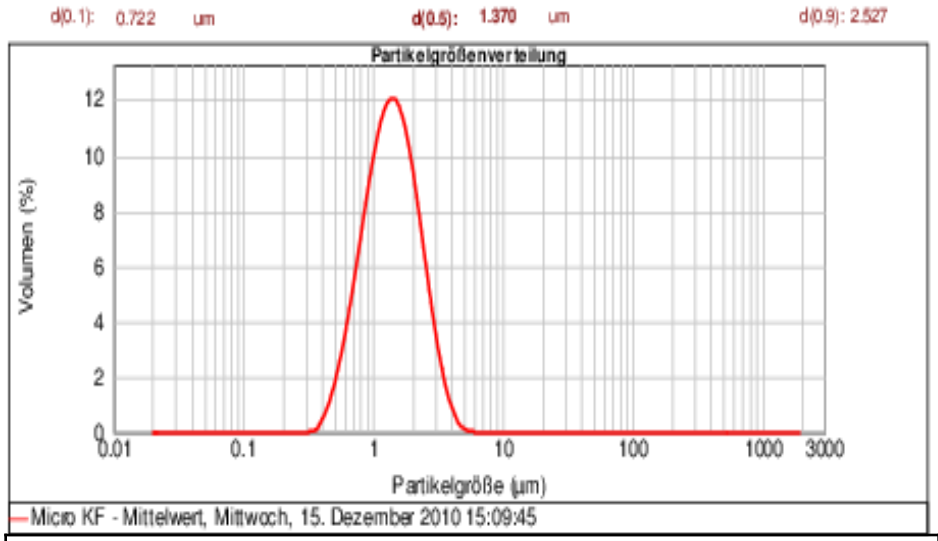
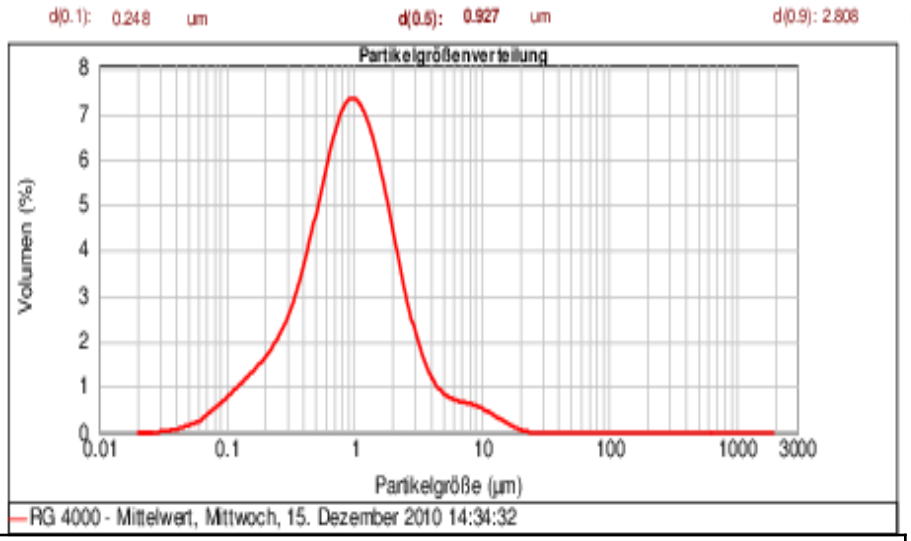
Size distribution of DURANTAL RX and Reactive Alumina (RA)





*Mastersizer analyse **DURANTAL RX***	*Mastersizer analyse **Reactive Alumina***
D10 – 0,72µm	*D10 – 0,28µm*
D50 – 1,37µm	*D50 – 0,93µm*
D90 – 2,53µm	*D90 – 2,81µm*

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Specific Surface of DURANTAL RX and Reactive Alumina

Sample	BET (m^2/g)
DURANTAL RX	18,265
Reactive **Alumina (RA)**	6,551

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Press for sample preparation

1000kg/cm²

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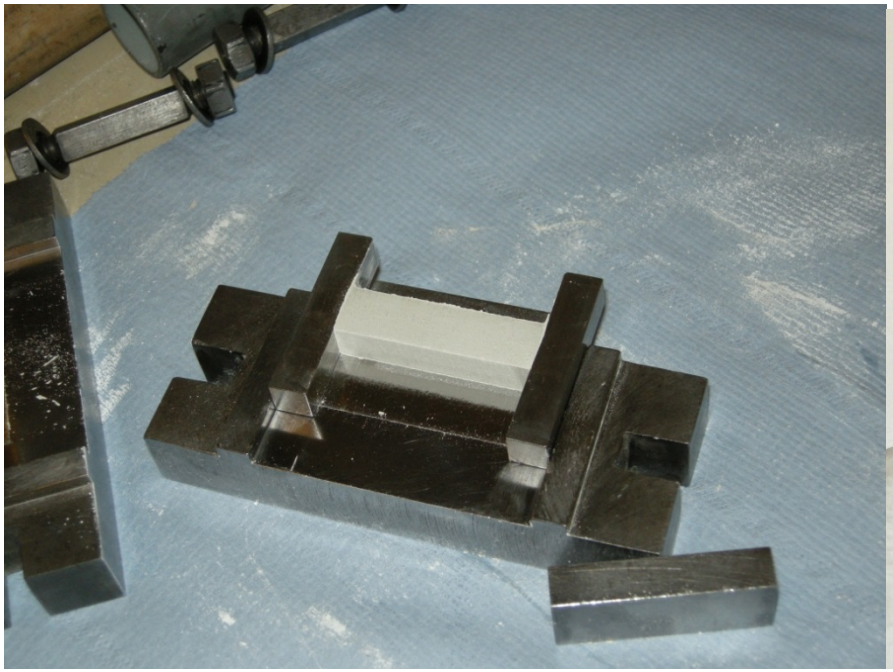
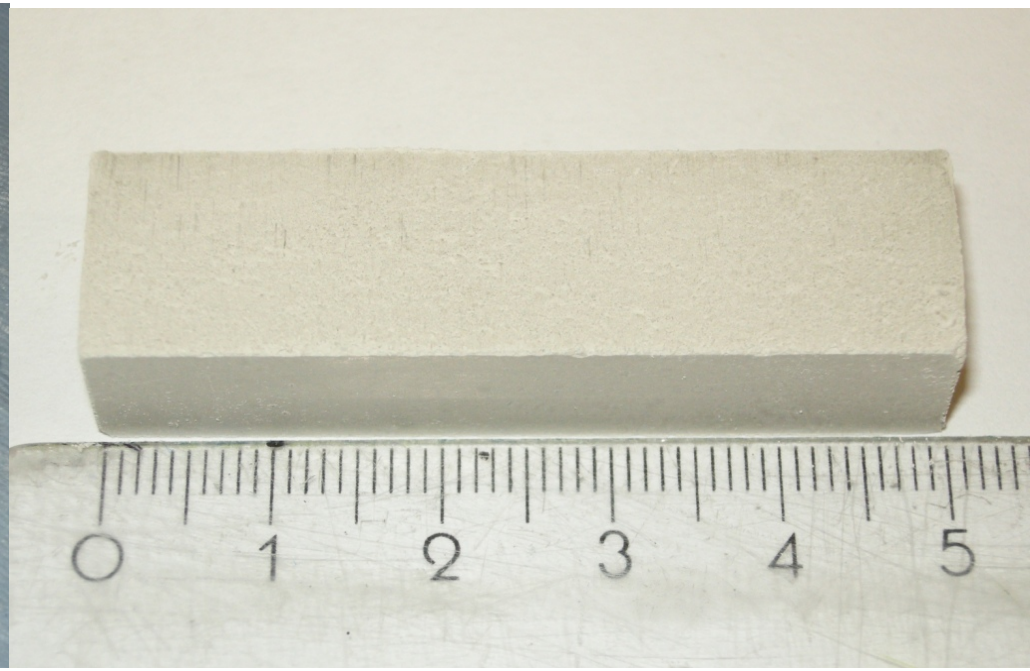
Samples to sinter



Brick in the mould



Green brick size: 50 x 10 x 12 mm

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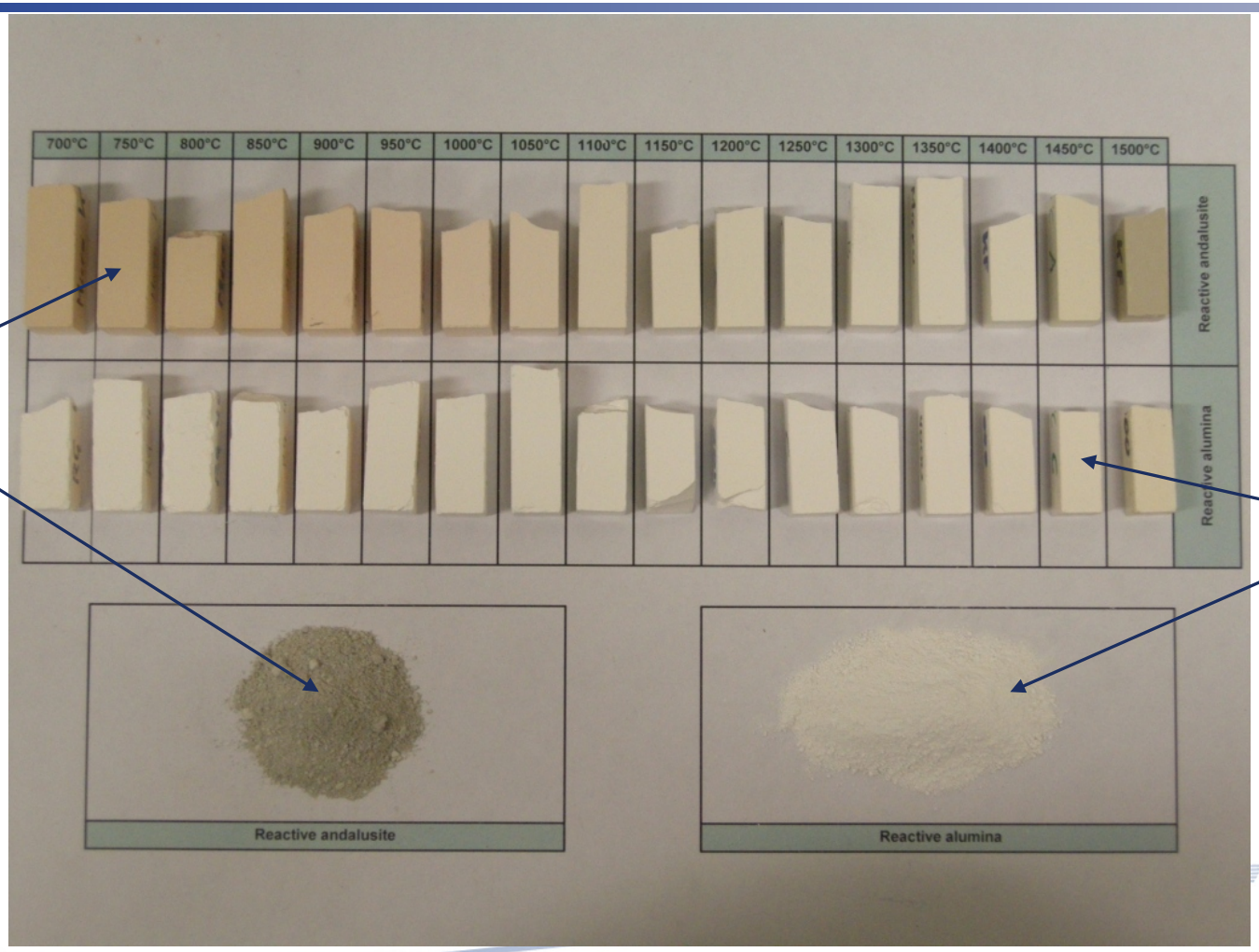
Samples after sinter and testing



RX

RA

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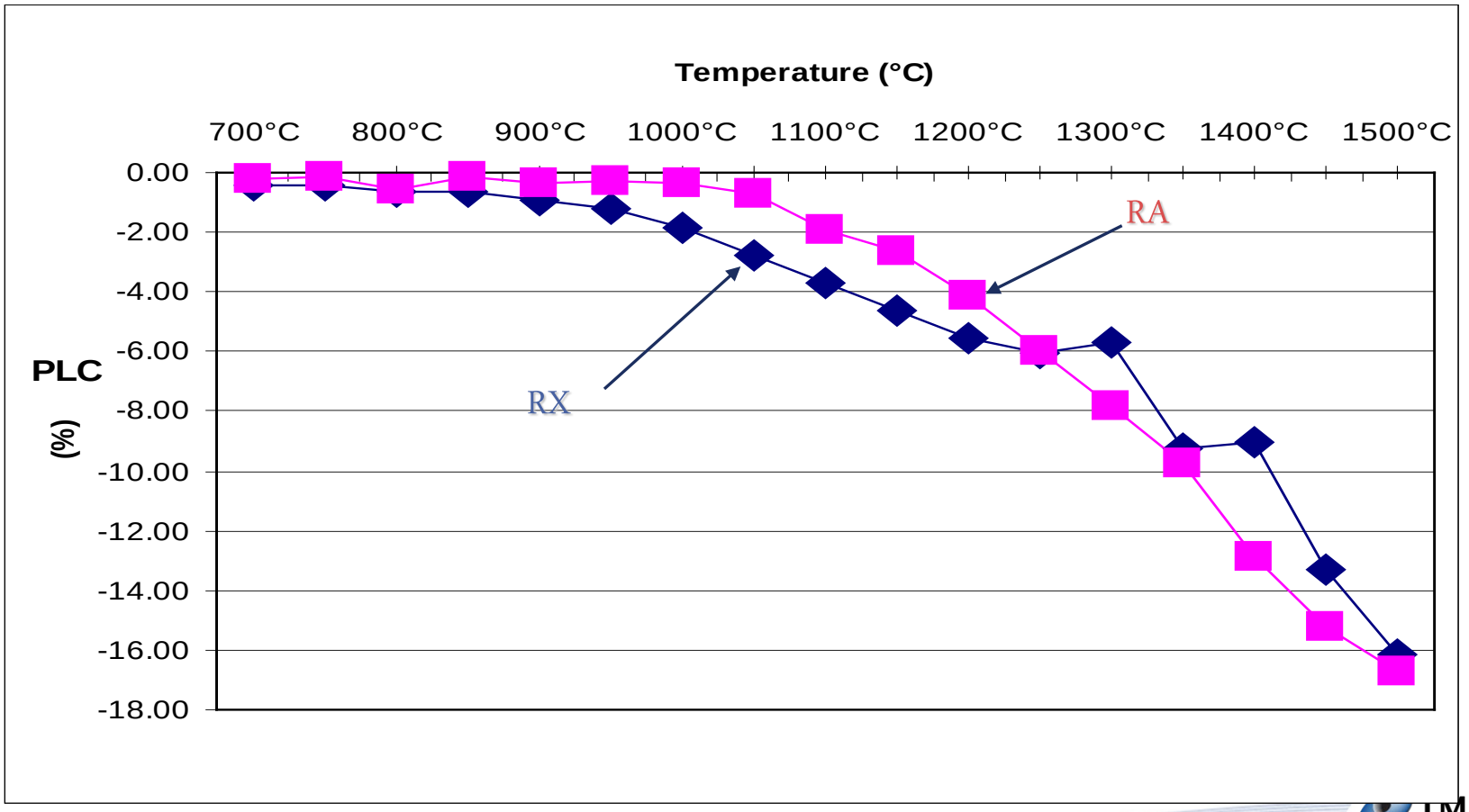
Shrinkage of RX and RA vs. sintering temperature



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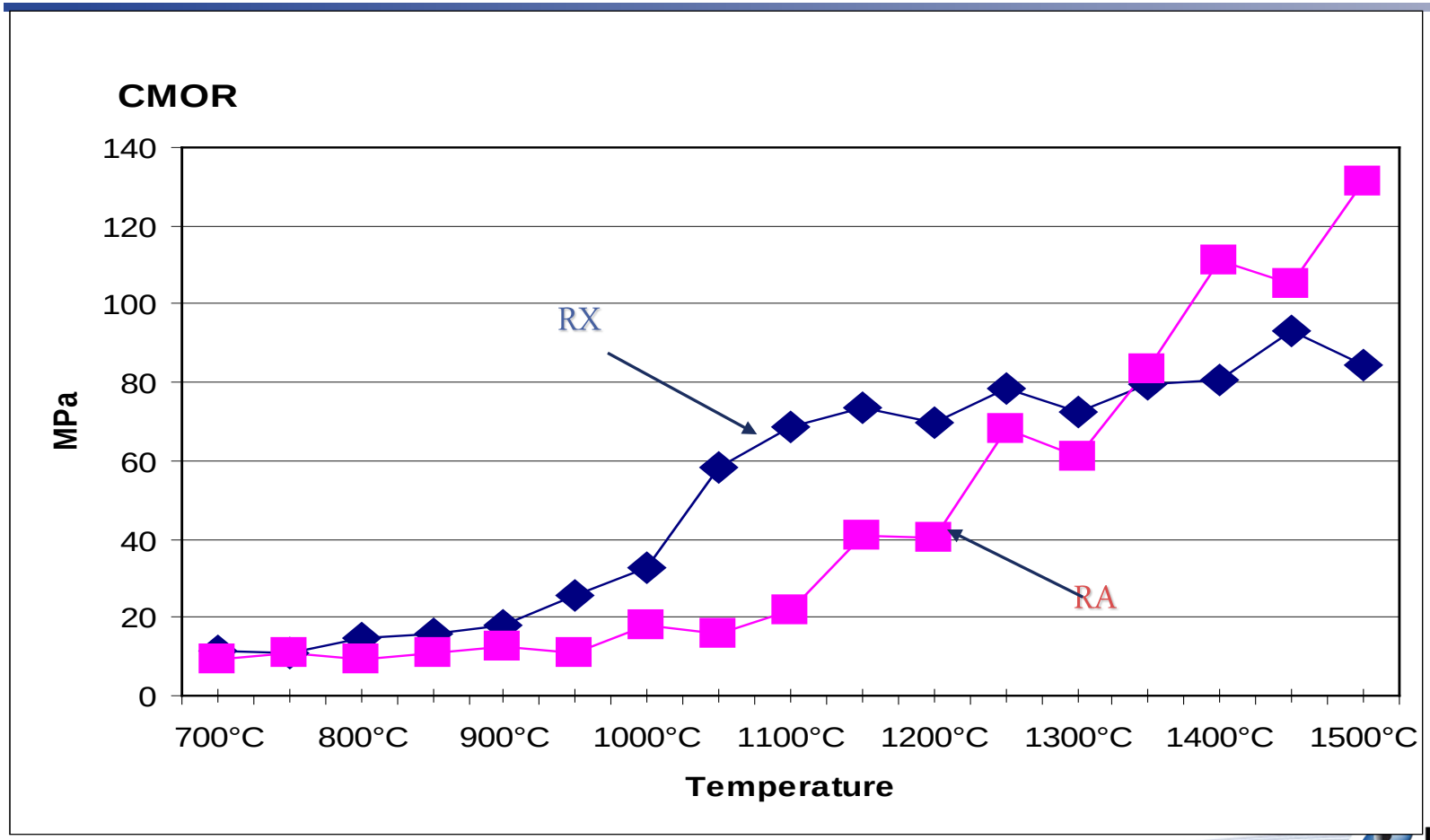
Cold module of rupture vs. sintering temperature



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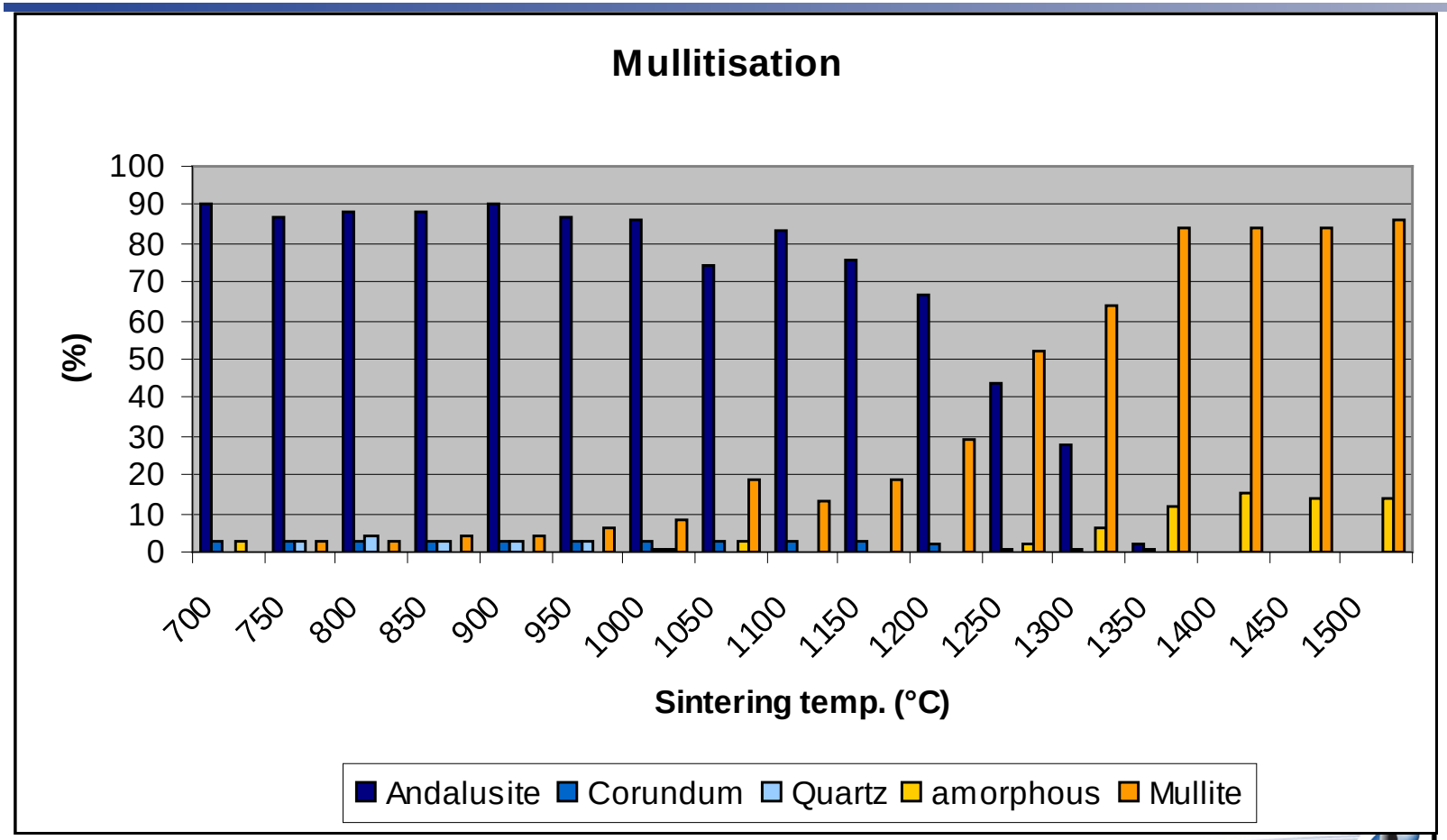
DURANTAL RX mullitisation vs. sintering temperature



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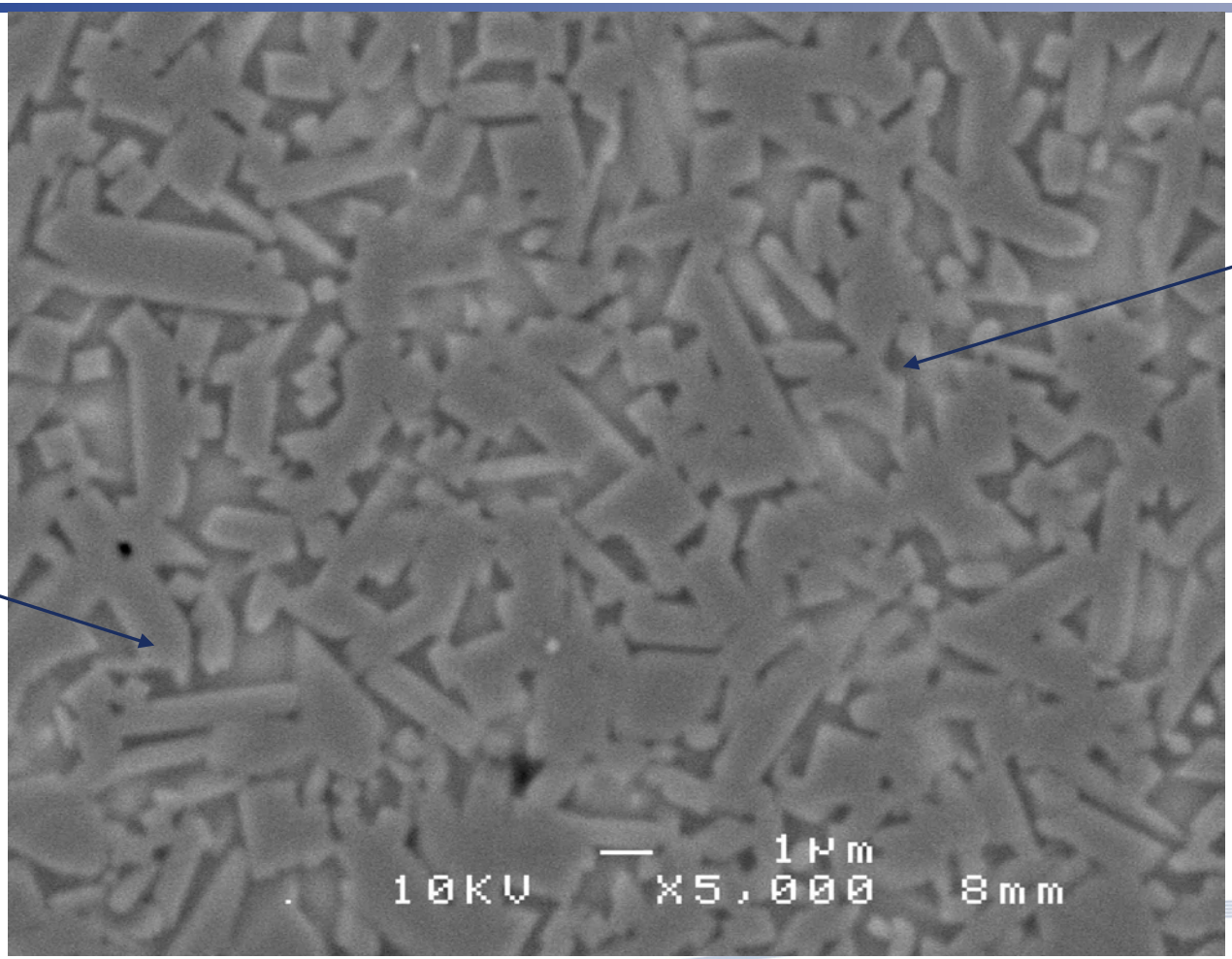
DURANTAL RX after sinter at 1500°C x 3h



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Substitution of Reactive Alumina (RA) by DURANTAL RX in LCC and ULCC Castable

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Comparison of ceramic bonding by measuring the cold mechanical strength (CCS and CMOR) from middle temperature to high temperature

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A pure corundum LCC castable used to test ceramic bonding strength

		Formulation	Formulation
		reactive alumina (RA)	**DURANTAL RX**
Raw Materials	Size	%	%
white fused alumina	2-5mm	33	33
white fused alumina	1-3mm	10	10
white fused alumina	0-1mm	20	20
white fused alumina	0-0.3mm	15	15
calcined alumina	5µ	11	11
reactive alumina		**6**	
Durantal RX			**6**
cement Kernous	Segar 71	5	5
STPP		0.15	0.15
TOTAL		100.15	100.15

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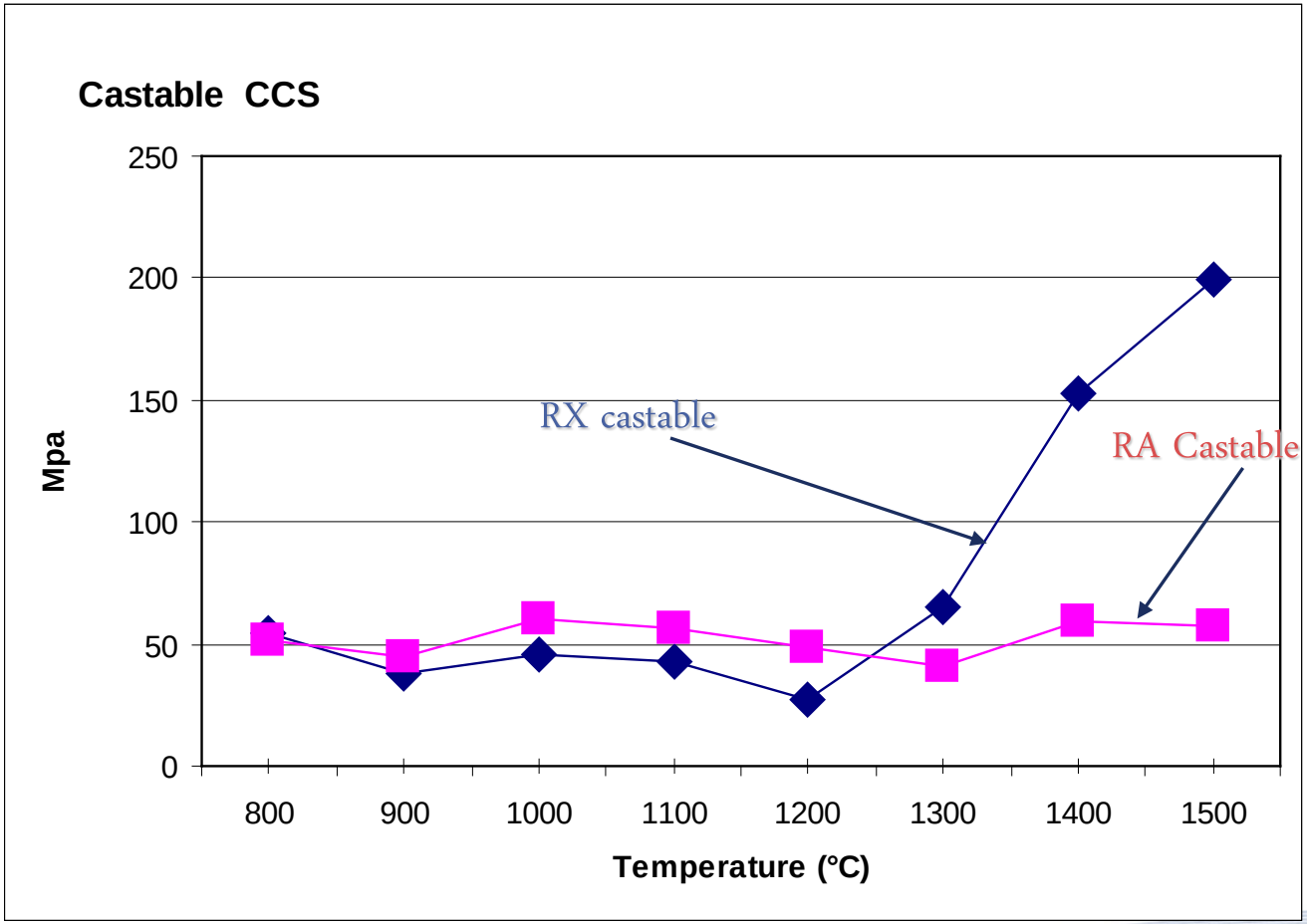
Cold Crush Strength vs. sintering temperature



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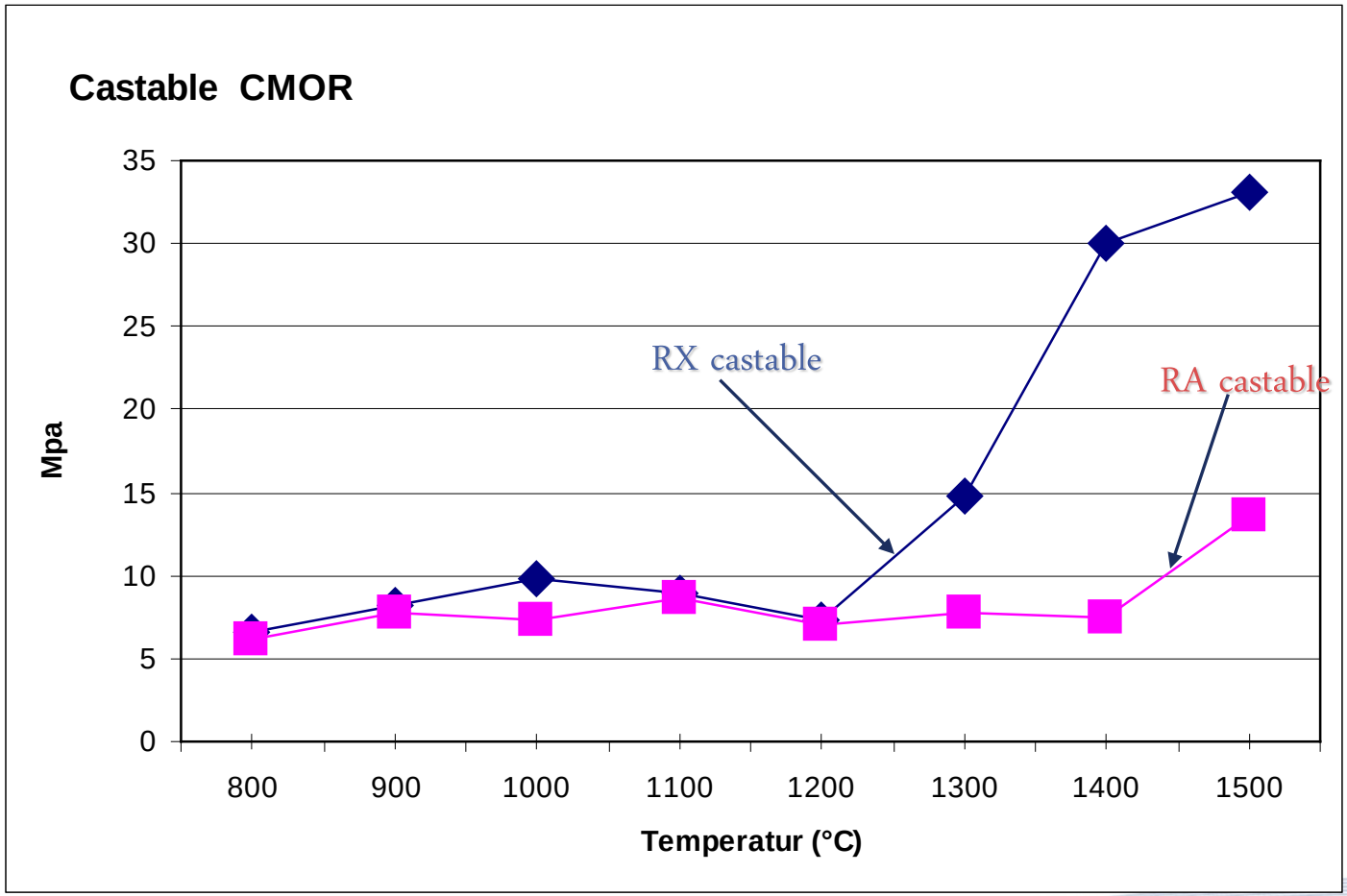
Cold module of rupture vs. sintering temperature



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Comparison of ceramic bonding by measuring the cold module of rupture (CMOR) in function with temperature

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3 Castables Varying Microsilica Content from 0 to 5%

		WFA castable		Spinel castable		Bauxite castable	
Raw Materials	size	formulation RA	formulation RX	formulation RA	formulation RX	formulation RA	formulation RX
white fused alumina	5-10mm			15	15		
white fused alumina	2-5mm	33	33	20	20		
white fused alumina	1-3mm	10	10	20	20		
white fused alumina	0-1mm	20	20	10	10		
white fused alumina	0-0.3mm	15	15				
sinter spinel 78%	0-0.5mm			5	5		
sinter spinel 78%	325M			14	14		
bauxite 88%	3-5mm					16	16
bauxite 88%	1-3mm					20	20
bauxite 88%	0-1mm					24	24
bauxite 88%	200M					20	20
Microsilica	**971U**			**0,5**	**0,5**	**5**	**5**
calcined alumina	5µ	11	11	5	5	5	5
reactive alumina	**1µ**	**6**		**6**		**5**	
DURANTAL RX	**1µ**		**6**		**6**		**5**
Cement	secar 71	5	5	5	5	5	5
STPP		0,15	0,15	0,15	0,15	0,15	0,15
TOTAL		**100,15**	**100,15**	**100,65**	**100,65**	**100,15**	**100,15**

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Casting property comparison

drying at 110° C

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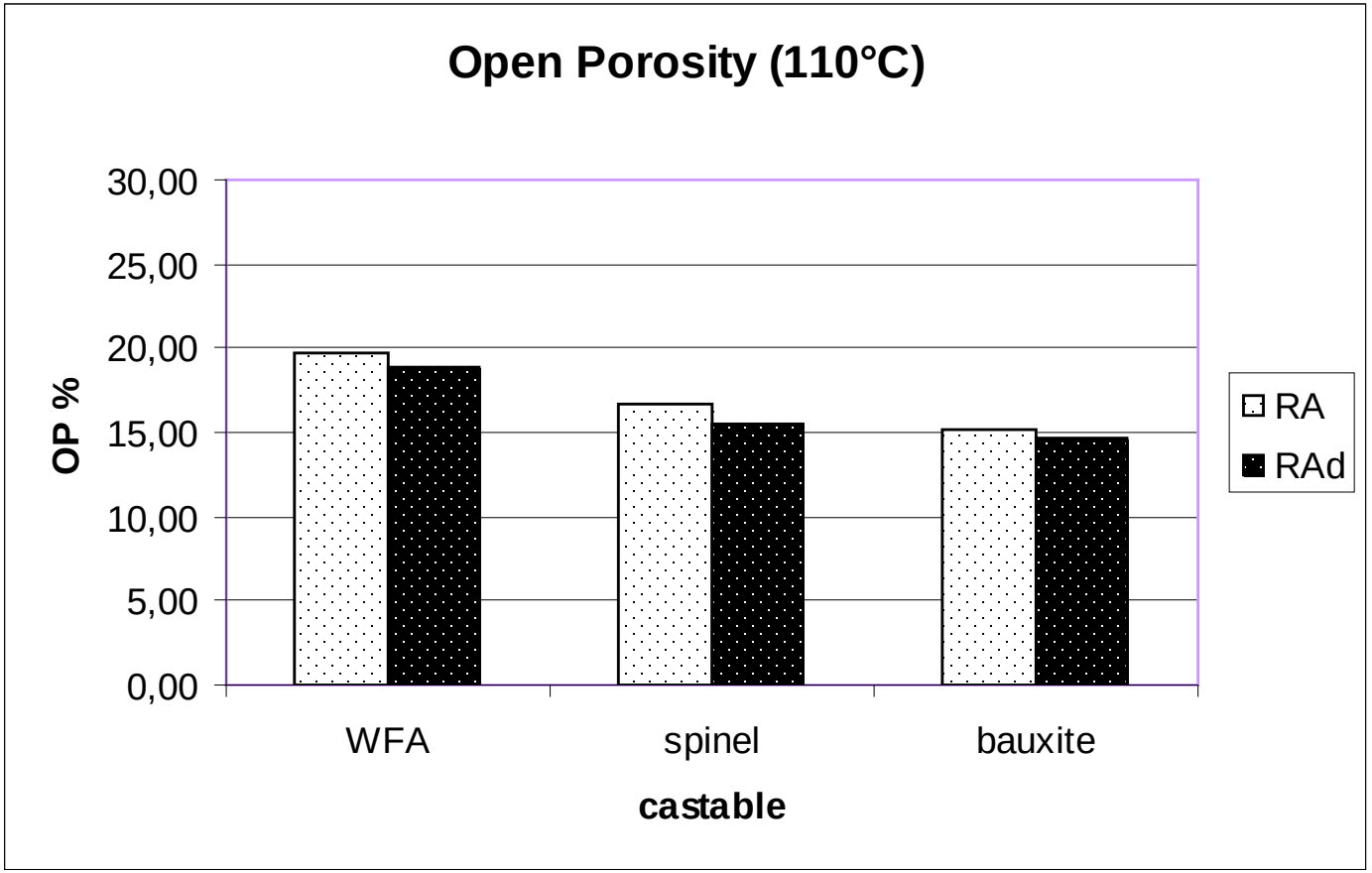
Substitution doesn't change open porosity



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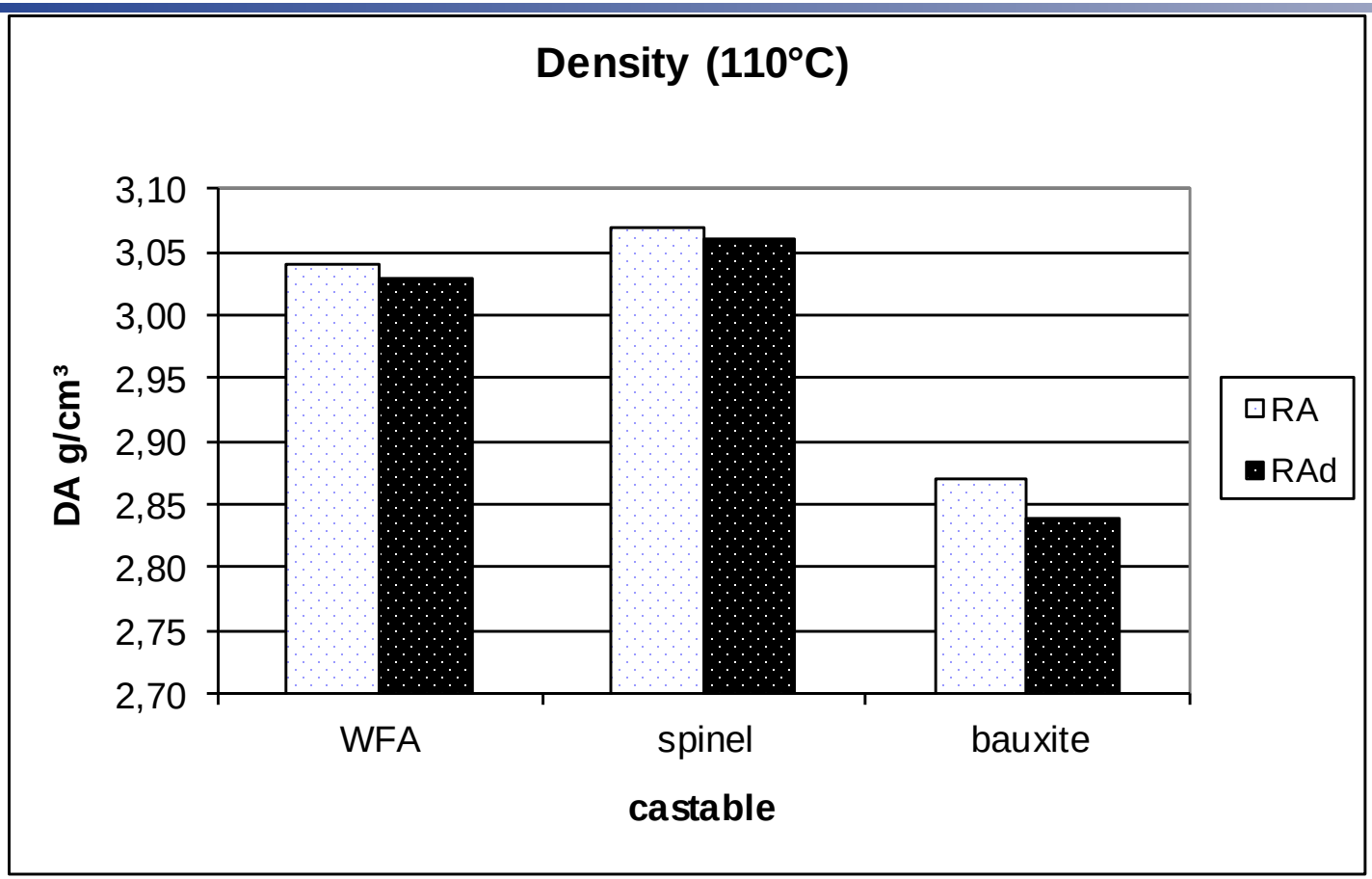
Low density of RX changes slightly the density of castable



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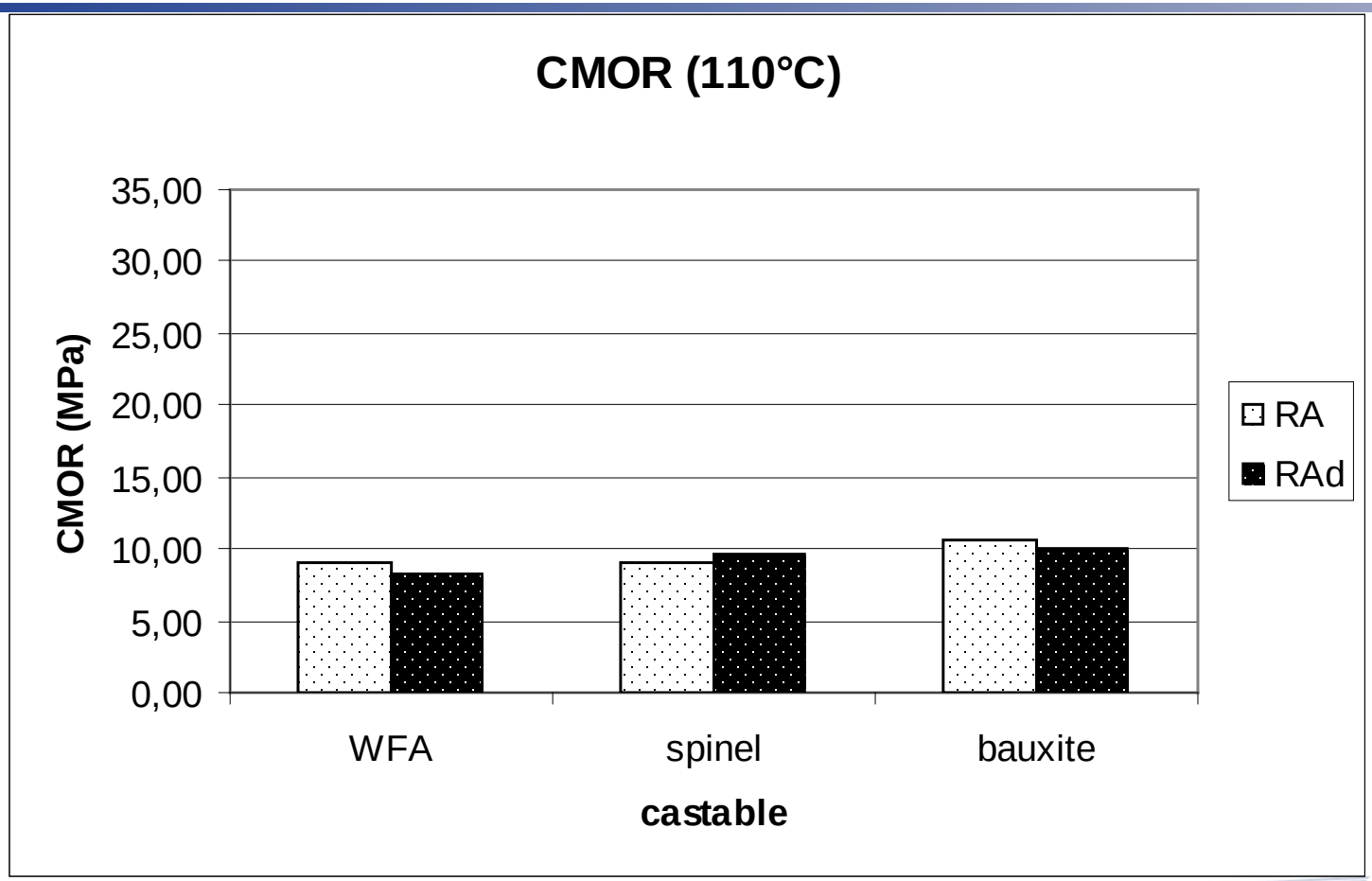
Cold module of rupture stays no change



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substitution of reactive alumina by reactive andalusite has no impact on casting quality of castable

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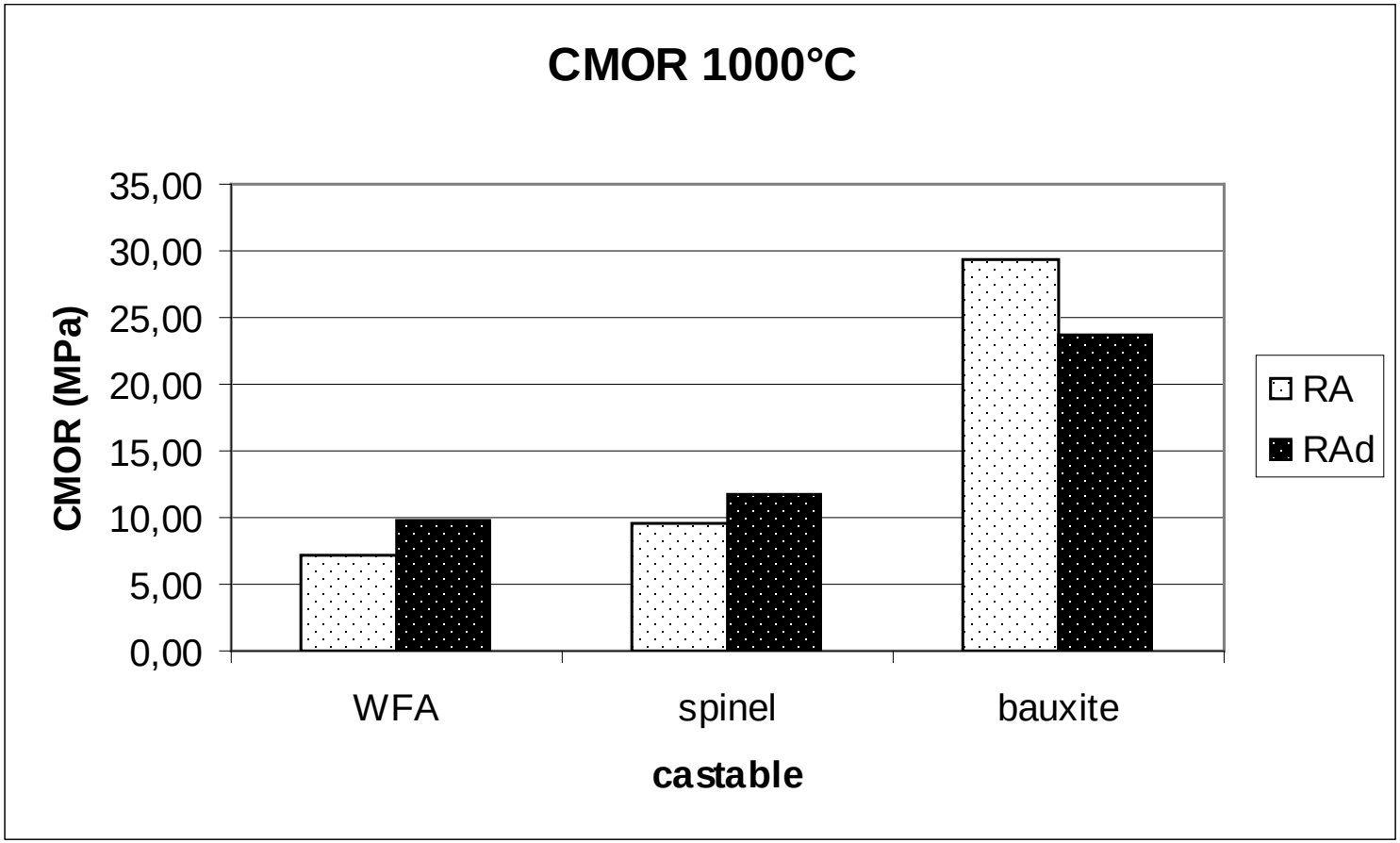
Cold module of rupture after sinter at middle temperature



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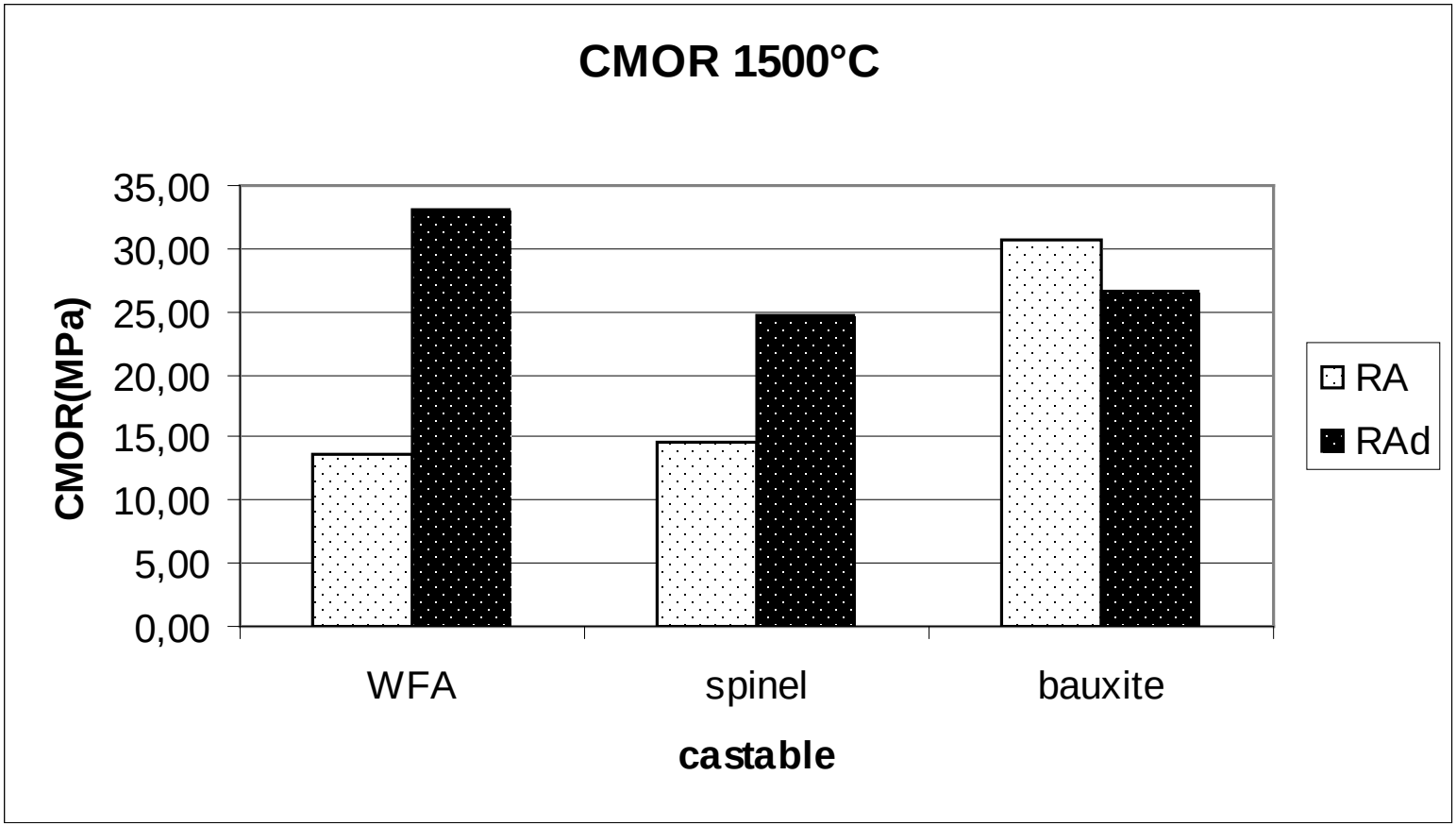
Cold module of rupture after sinter at high temperature



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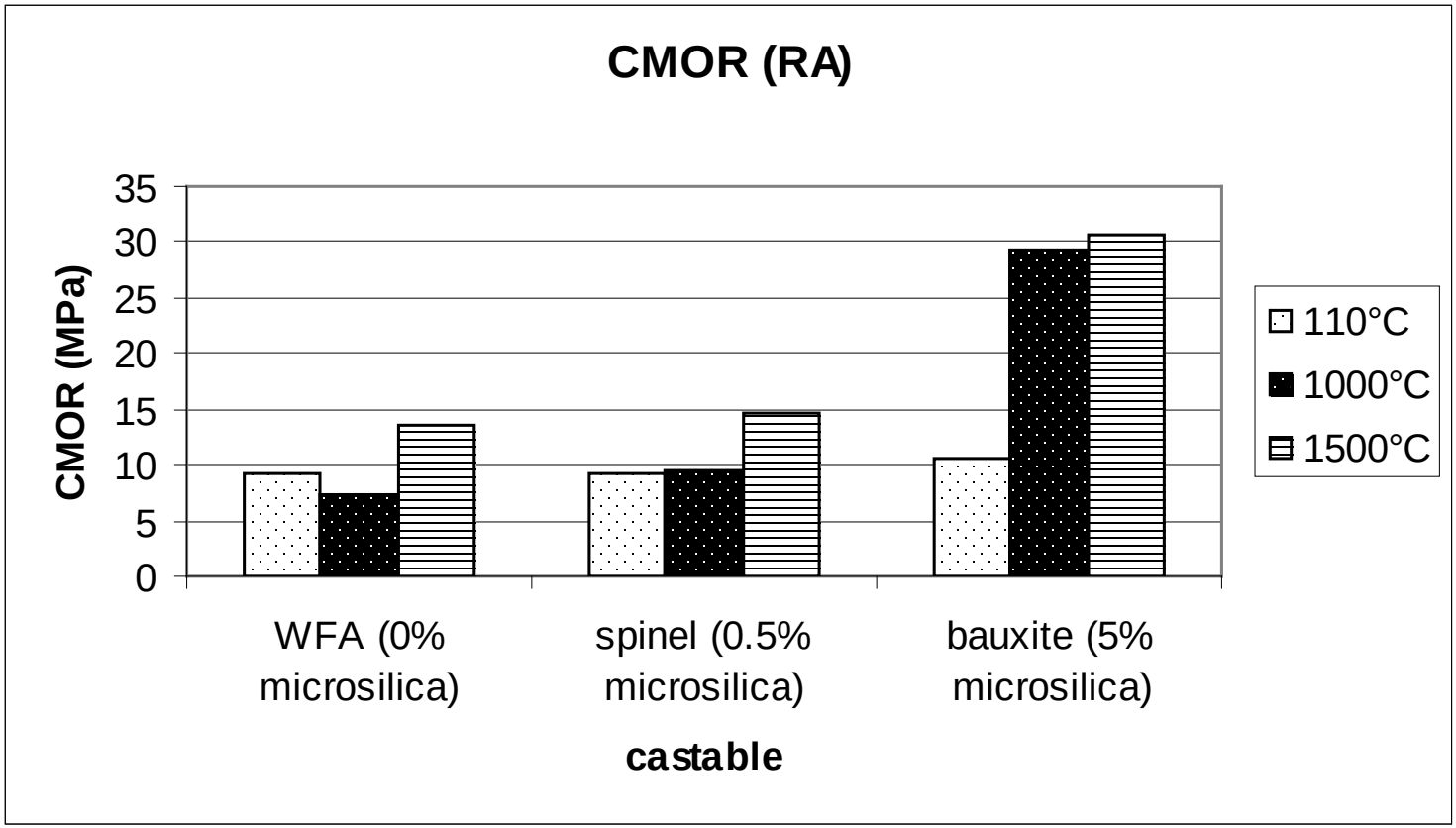
Evolution of Cold module of rupture with temperature (Reactive alumina added castable)



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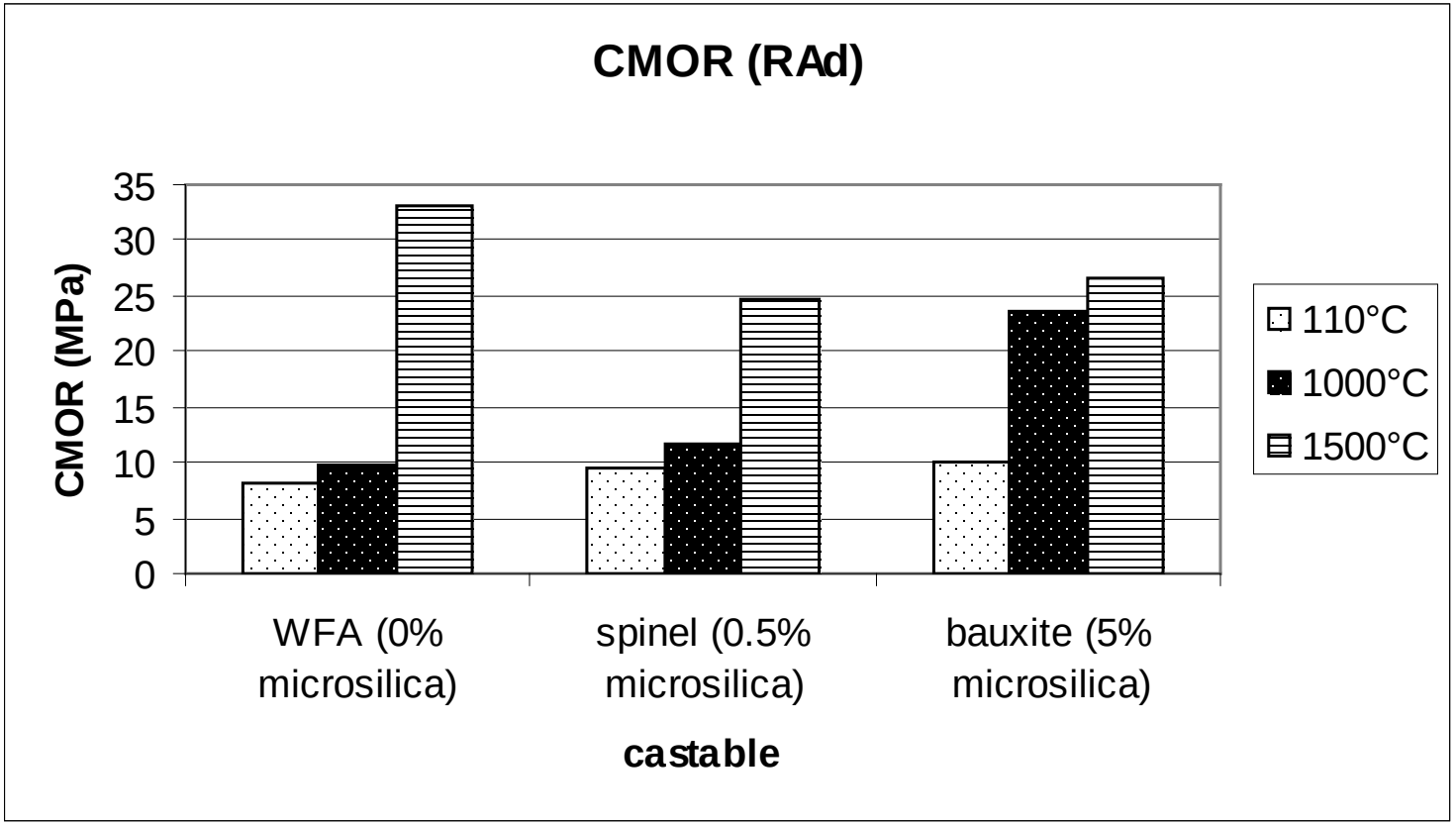
Evolution of Cold module of rupture with temperature (reactive andalusite added castable)



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CONCLUSIONS

DURANTAL RX starts its mullitisation around 950°C and ends around 1350°C.

Starting temperature of ceramic bonding formation by DURANTAL RX is 150°C below starting temperature for creating a ceramic bonding with reactive alumina.

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CONCLUSIONS

For castables with microsilica addition (3-5%), DURANTAL RX develops the same level bonding strength as reactive alumina from middle temperature to high temperature.

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CONCLUSIONS

For microsilica free castables, in middle temperature around 1000° C, the ceramic bonding created by DURANTAL RX has the same level of strength than ceramic bonding due to reactive alumina. But in high temperature, DURANTAL RX develops a stronger bonding.

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CONCLUSIONS

DURANTAL RX can be used as Reactive Alumina to create ceramic bonding in LCC and ULCC castable

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MUCHO GRACIAS POR SU ATENCION

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