FUNCTION AND BENEFIT OF BOUNDARY ACTIVE COATINGS

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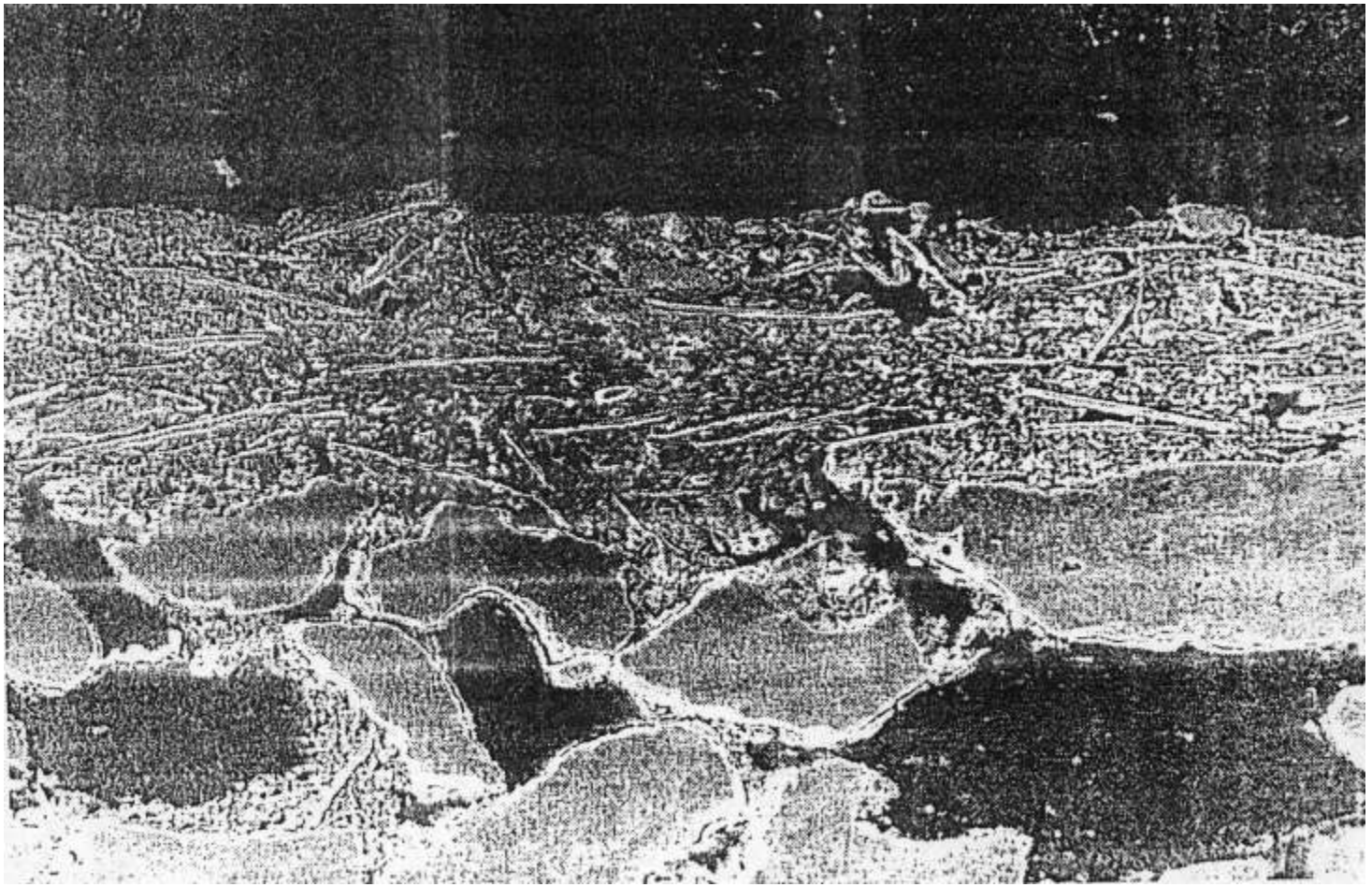
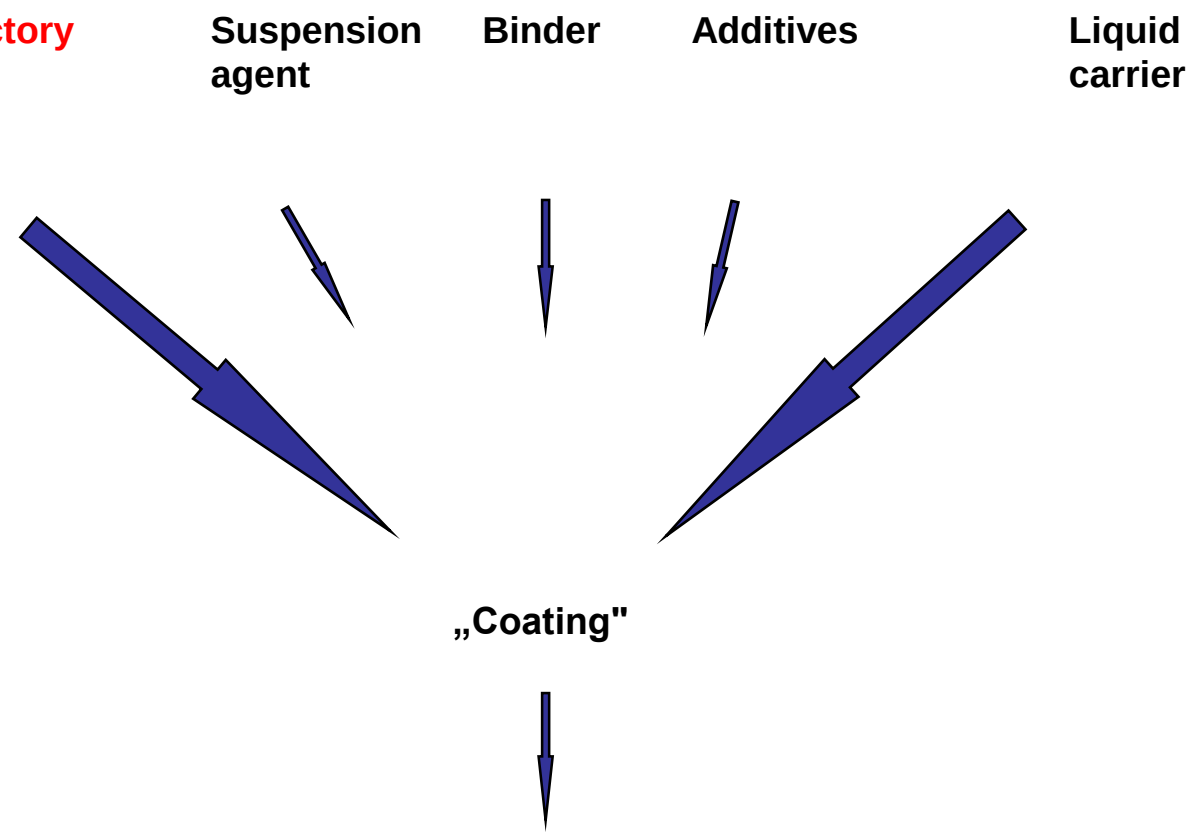
The importance of coatings

Section of a coated ColdBox-mould substrate,

REM-Aufnahme, Vergr. 80x, Quelle: Gießerei-Praxis Nr. 6-1993

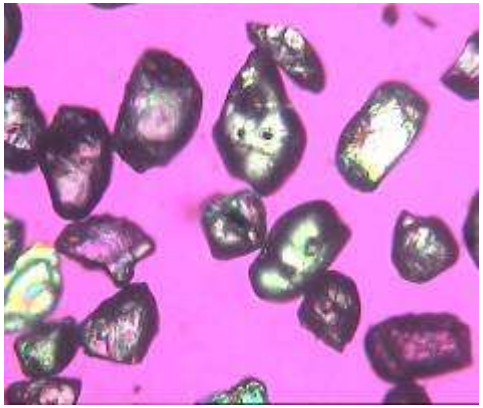


How are coatings designed?

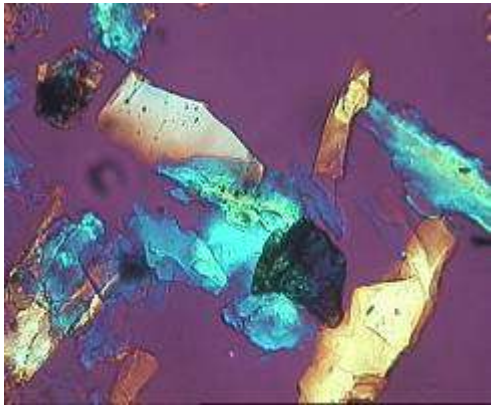


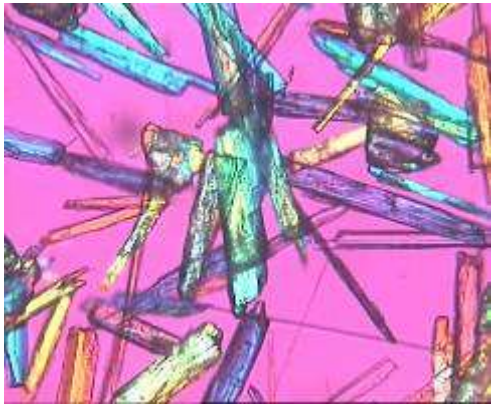
Types of coatings

- Grains -



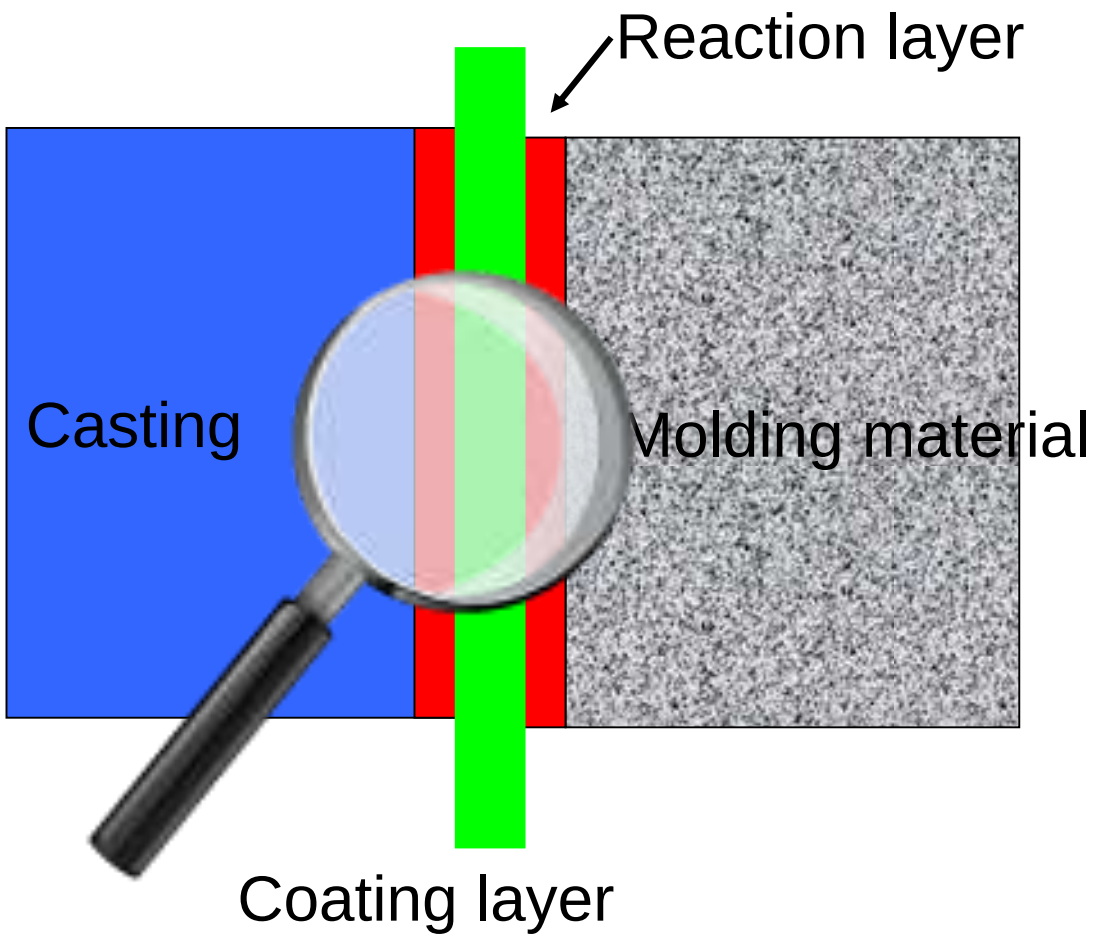
- Plates-





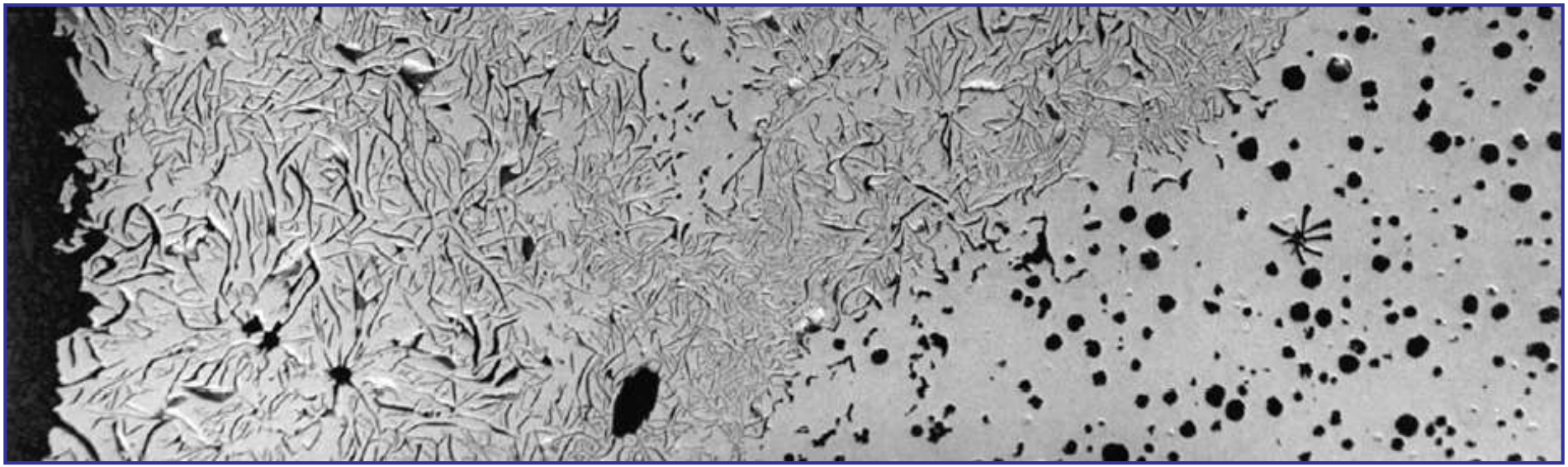
Refractory	Density g/cm³	Meltingpoint °C	Morphology	Chemical formula	Application
Zircon-silicate	4,6	2200	angular	$ZrSiO_4$	Steel
Corundum	4,0	2050	angular	Al_2O_3	Steel
Magnesite	3,7	2800	angular	MgO	Manganese steel
Mullite	3,16	1700	angular	$3\ Al_2O_3 \cdot 2\ SiO_2$	Iron
Graphite	2,3	3700	Plates	C	Iron, Aluminium
Kaolinite	2,65	> 1700	Plates	$Al_2((OH)_4/Si_2O_5)$	Iron
Pyrophillite	2,8	1600	Plates	$Al_2((OH)_2/Si_4O_{10})$	Iron, Aluminium
Talc	2,8	> 1000 max. 1430	Plates	$Mg_3((OH)_2/AlSi_4O_{10})$	Iron, Aluminium
Mica	2,85	> 900	Plates	$KAl_2((OH)_2/AlSi_3O_{10})$	Iron, Aluminium

Reaction with coatings



Prevention of graphite degeneration

Graphite degeneration



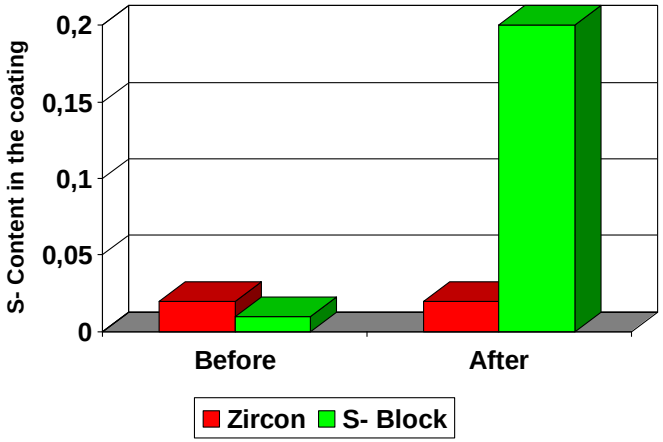
Formation mechanism

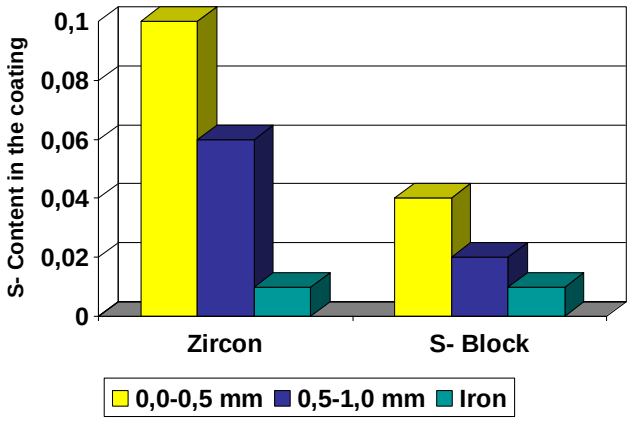
1. Degeneration of catalyst
   $C_7H_7\ SO_3H \longrightarrow C_7H_7OH + SO_2$
   $\partial S/\partial t \sim k_a\,[A]$ $\quad k_a = F(T)$
2. Transport of SO_2 to the surface
   $\partial S/\partial t \sim \eta\,[B]$
3. Reaction with sulphur stop
   $\partial S/\partial t \sim -k_c\,[C]\,[Ca]$ $\quad k_b = F(T)$
4. Pick up of SO_2 into the melt
   $\partial S/\partial t \sim k_d\,[D]$
5. Reduction of SO_2
   $\partial S/\partial t \sim k_c\,[E]$

Graphite degeneration

- Steel and ductile iron (GJS) are sensitive to wards the sulfur absorption from the No-Bake-System
- The sulfur absorption can be reduced with the sulfur reduced No-Bake-System (Askuran RS system)
- Sulfur absorbing coatings are an effective protection against graphite degeneration
- Sealing coatings

Graphite degeneration





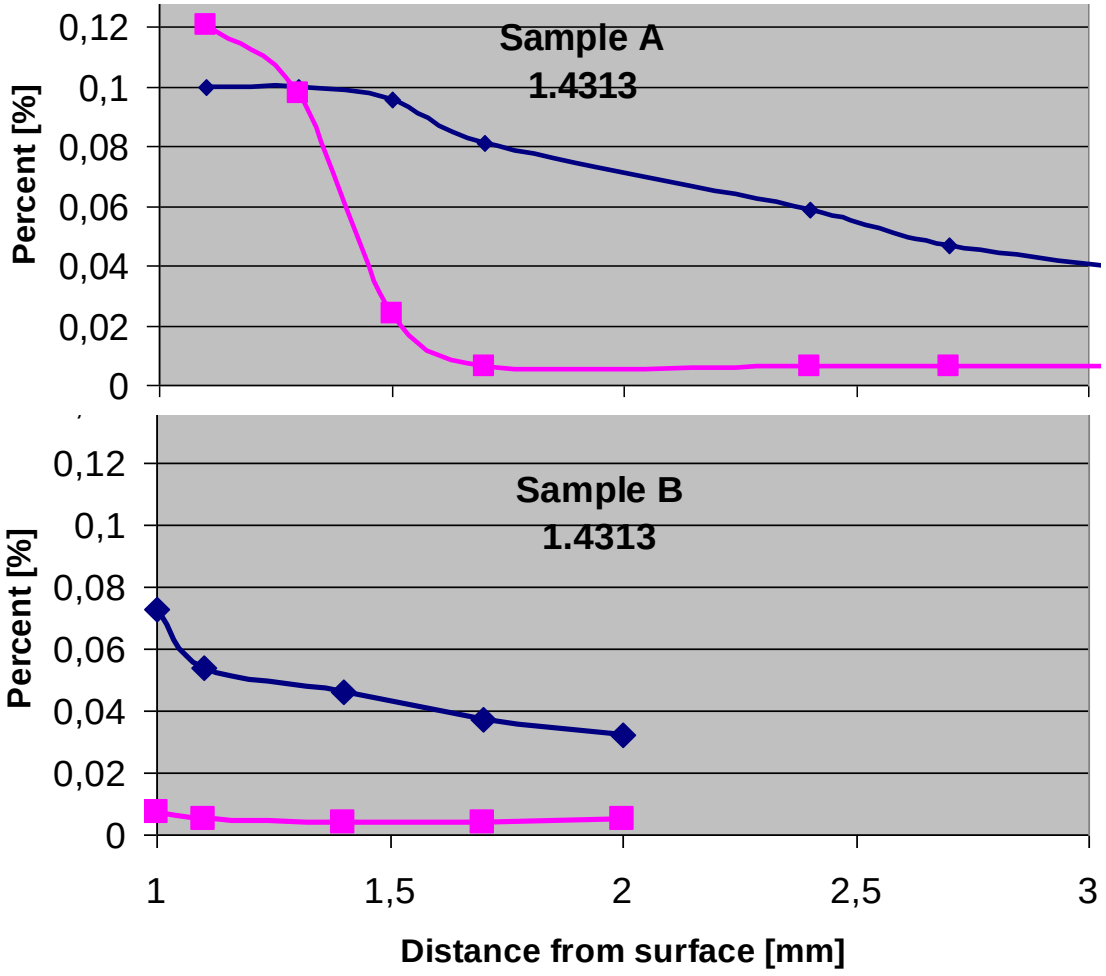
Nodular graphite degradation

Sample	1. Layer	2. Layer
A	Zirconium	Zirconium
B	Silico 200 P A	Silico 200 P

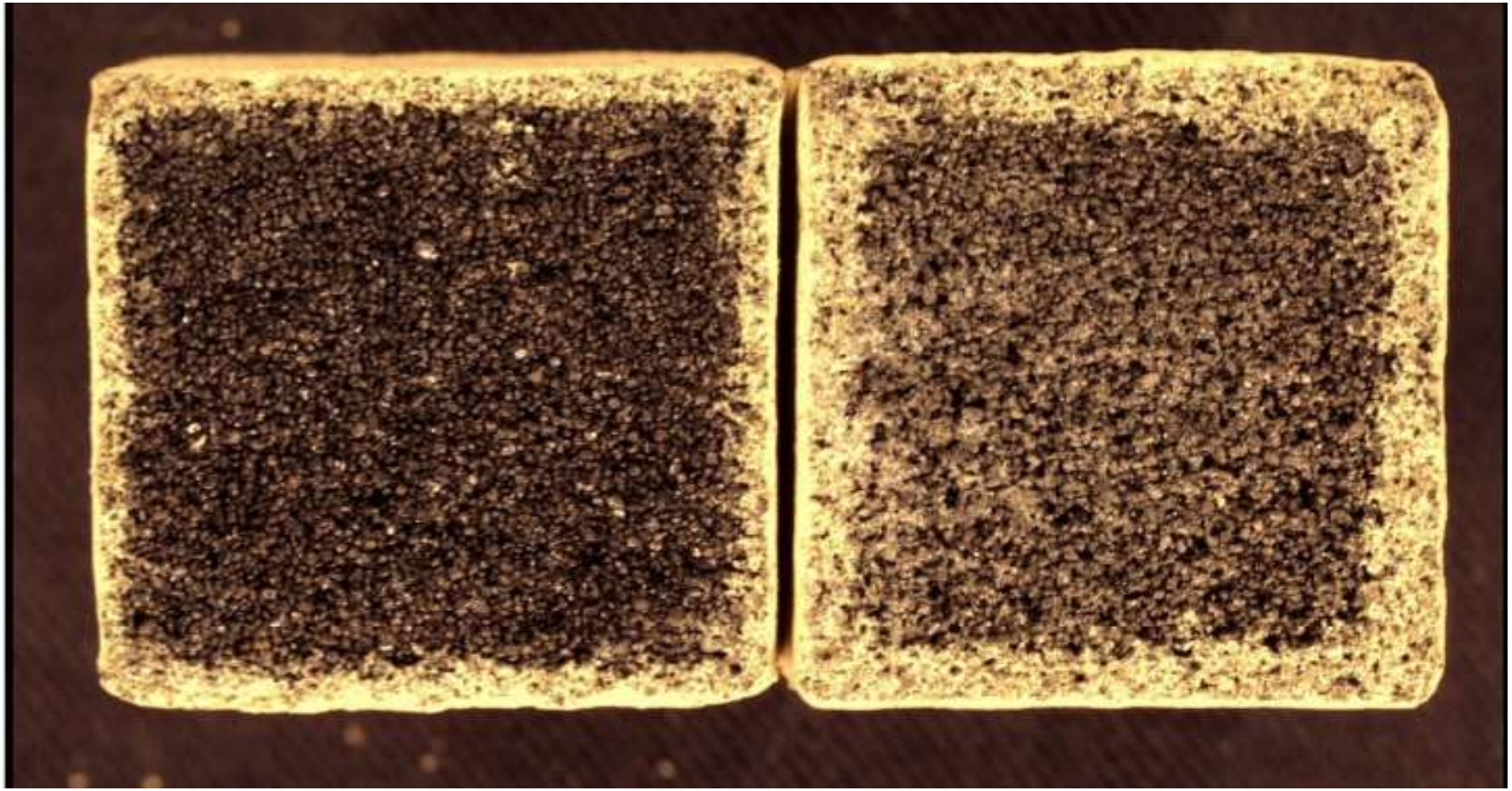
- Alloy 1.4313
- Pouring temperature 1560°C

C	Si	Mn	P	S	Cr	Ni	N	Al
[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
0,028	0,39	0,77	0,018	0,006	12,4	3,77	0,027	0,032

Nodular graphite degradation



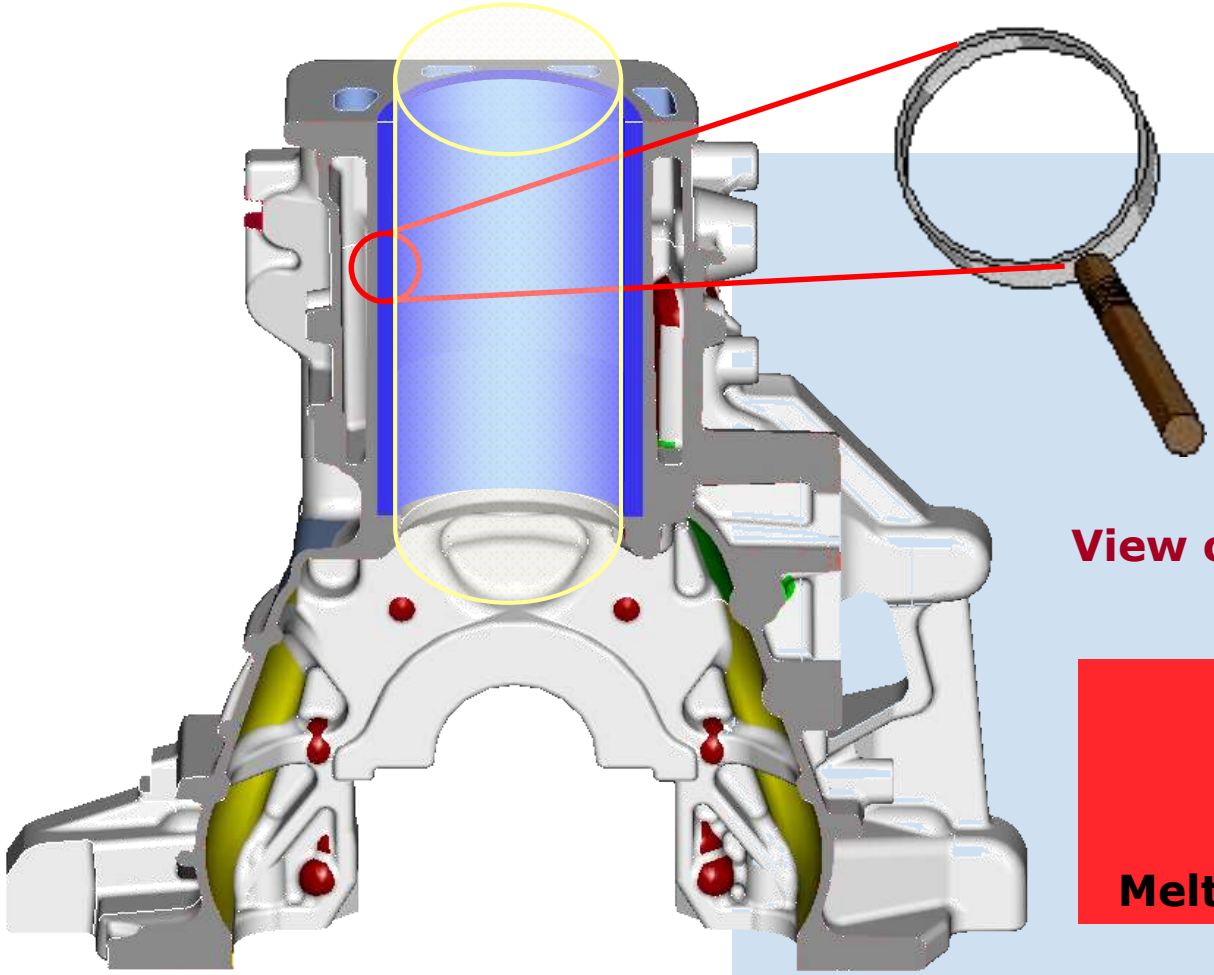
Thin walled castings



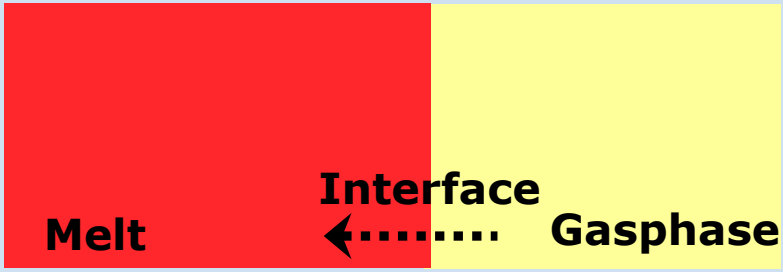
Impregnation Coating is forgiving less compaction

Formation of graphite degeneration

Gradient casting



View on physical system

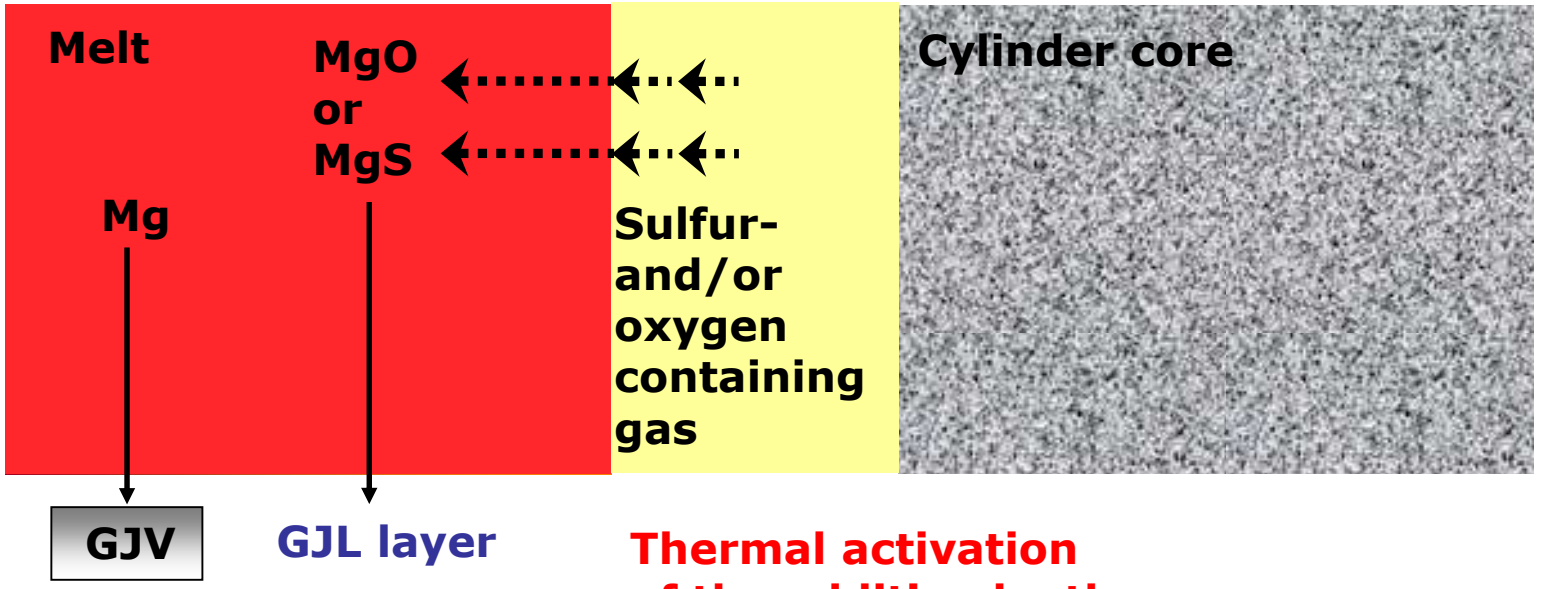


HALBERG GUSS

Gradient casting

Mg +MgO +MgS +$MgSiO_2$ = Mg in melt

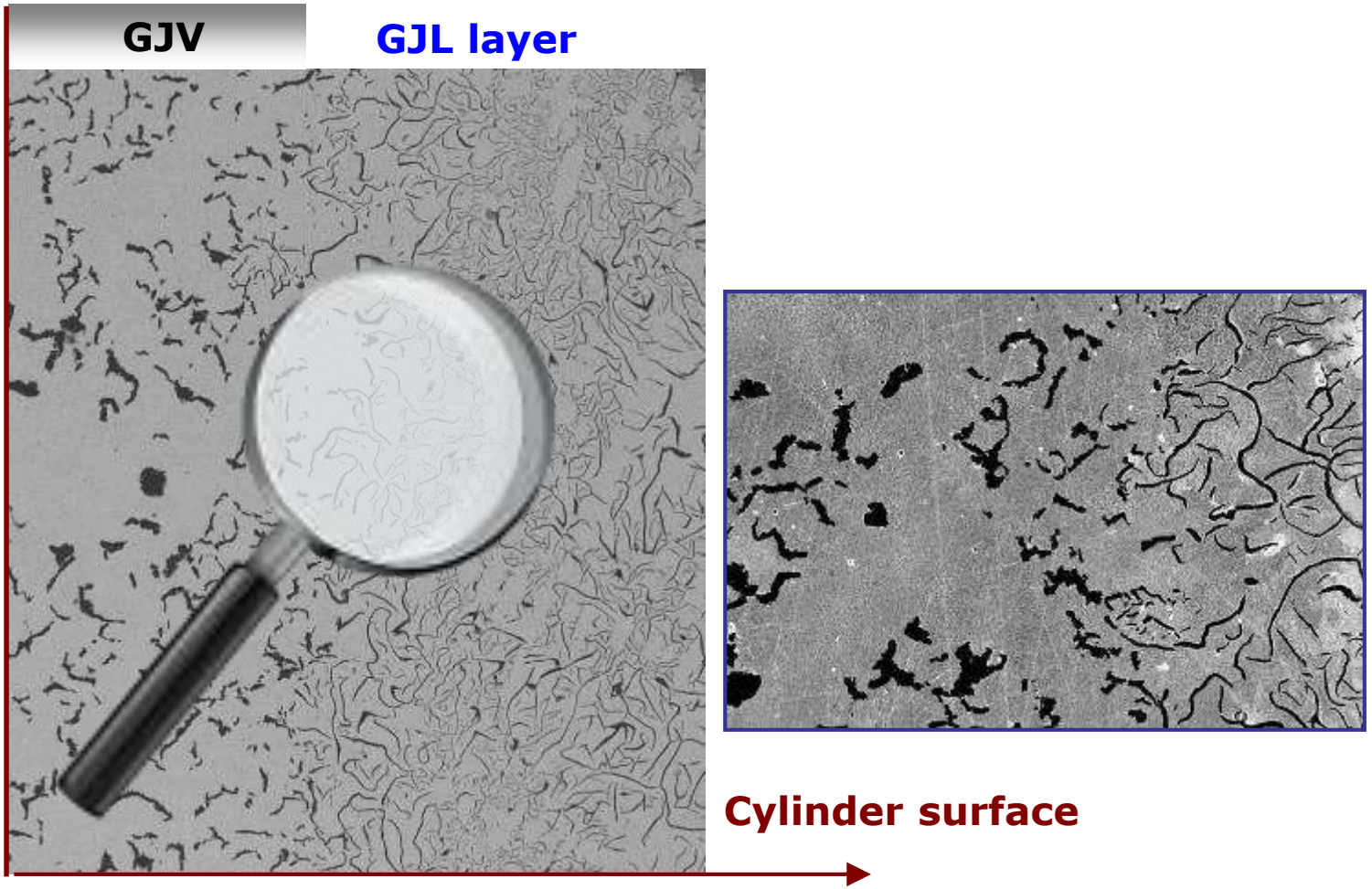
Leads to the formation of GJV
Aktiver für die Graphitausbildung entscheidender Gehalt??



Thermal activation of the additive by the temperature emission of the melt

HALBERG GUSS

Gradient casting



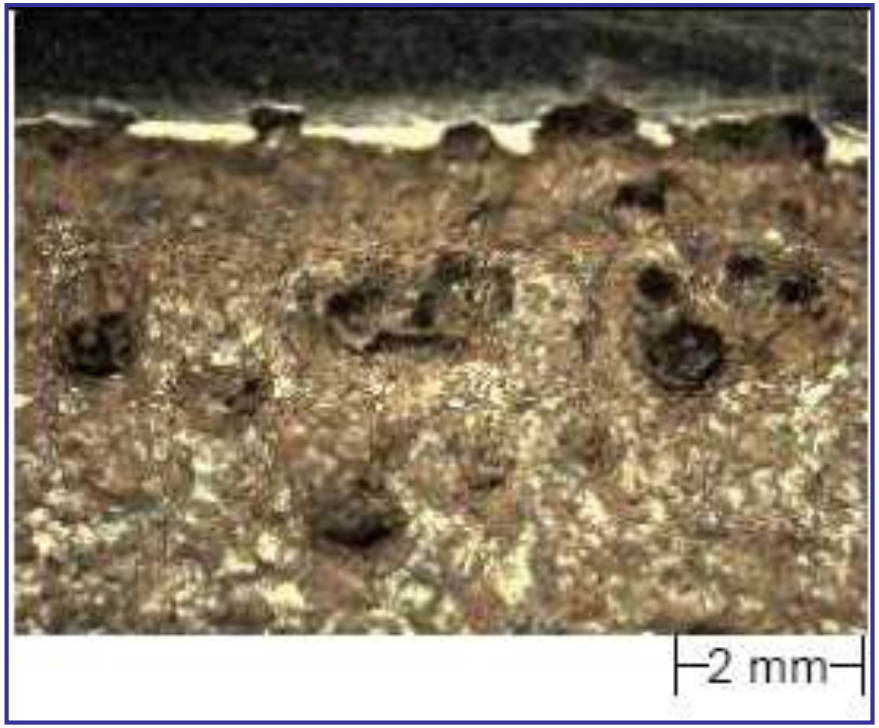
HALBERG GUSS

Scarred surface by GJS

Reactions with GJS

Sand Metal Reactions

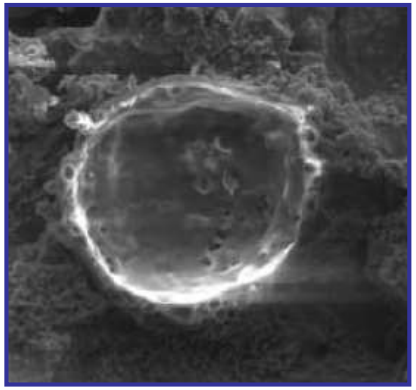
Reaction layer

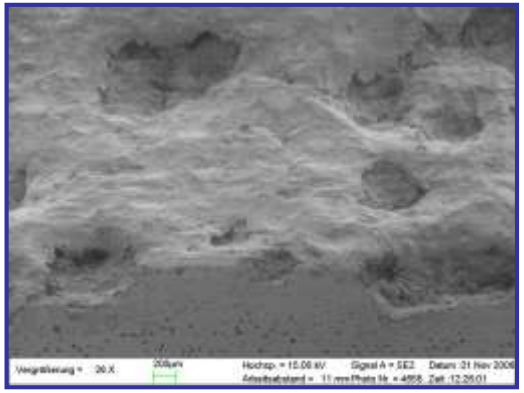


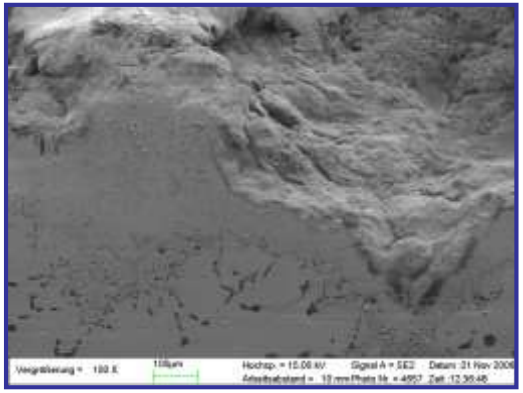
Casting surface

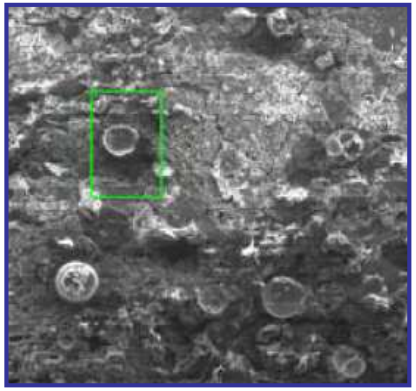
Scarred surface with holes

- Former liquid FeO_X-phase
- Scarred surface with holes
- Reaction layer and –products
- Blow structure

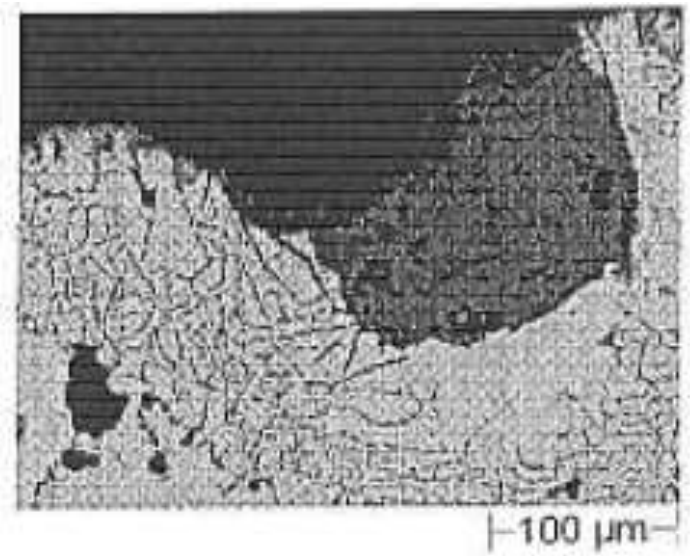


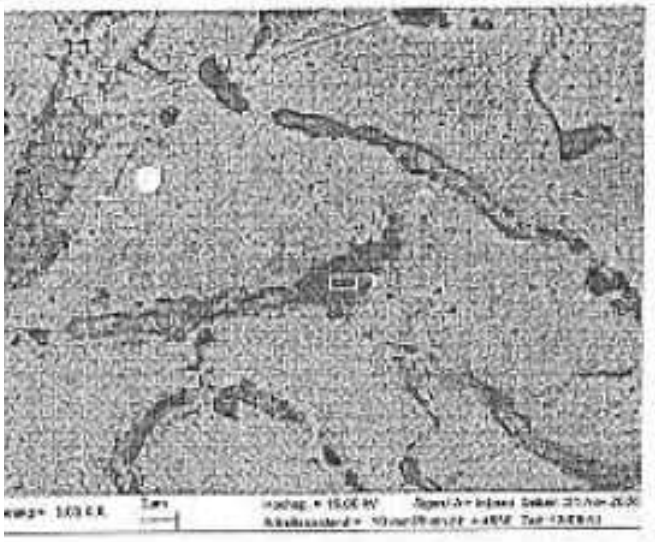






Area with reaction layers



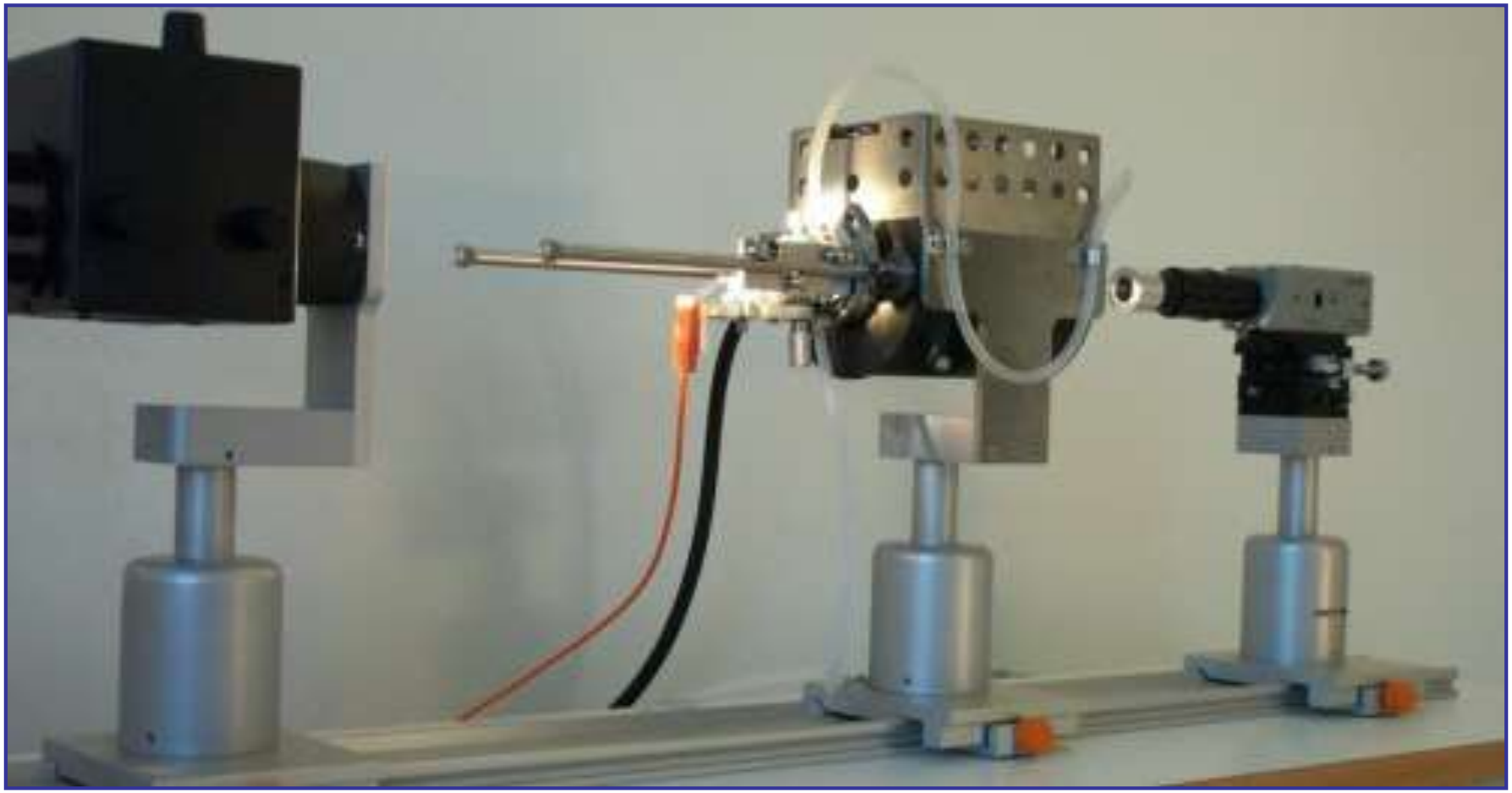


- Lamellar SiCxOy

Foam- and defect formation

- Creation of high viscous melt
- Foam expanse by gas pressure
- Presses against casting and sand
- Function of
  - Freezing alloy
  - Viscosity of the oxidized phase
  - Gas pressure
- Pressure has to escape -> defect in casting
  - comparison: PU-Foam, Pop-Corn

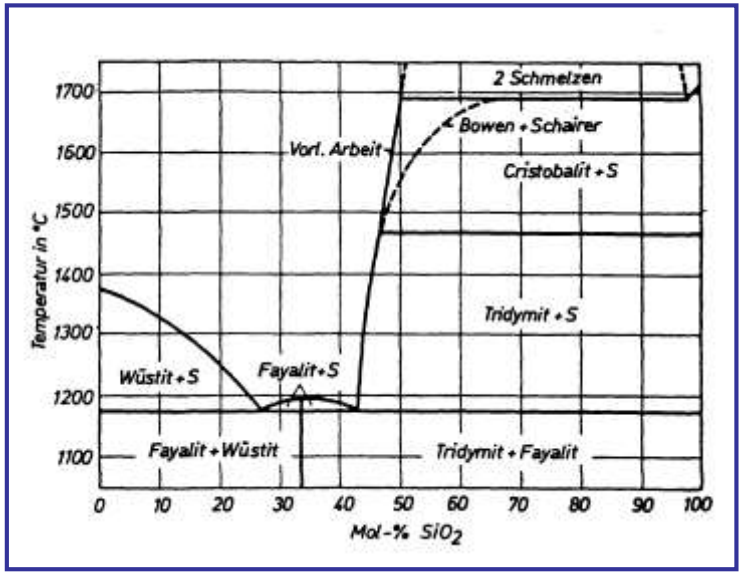
Building of glass and foam like structure



Building of glass and foam like structure

Liquid phase in mold

- Melting point degradation in mold or melt
  - Na, K, Mg, Ca, Al, Ti, S, P -> Oxides are problematic
- Requirements: oxygen in melt
  - mp dross lower
- FeO-SiO_2-System
  - Eutektika at about 1180 °C
  - Further degradation

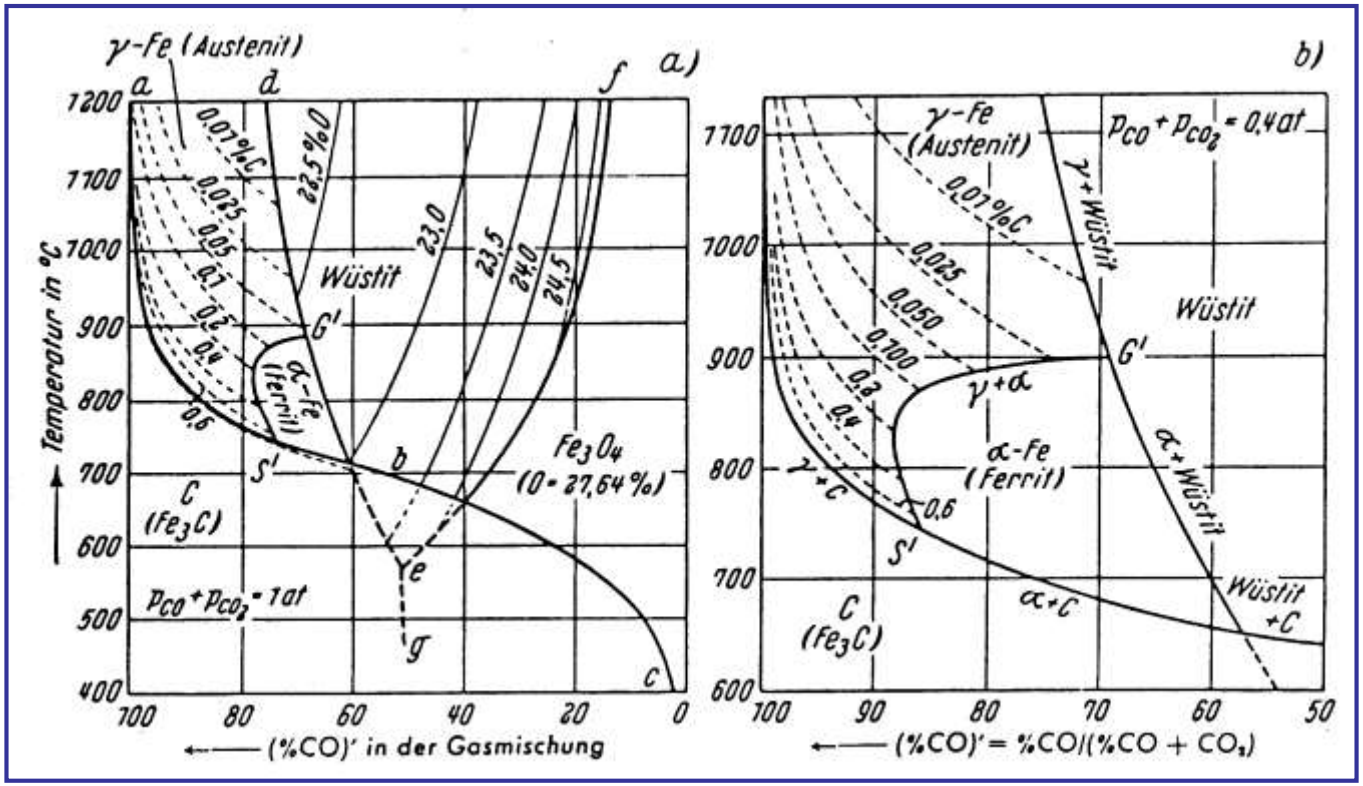


Gas pressure

- Gases are build by pyrolysis
  - Regenerated sand
  - Binder
  - Additive
  - Coating
- Air in sand holes

Formation of holes

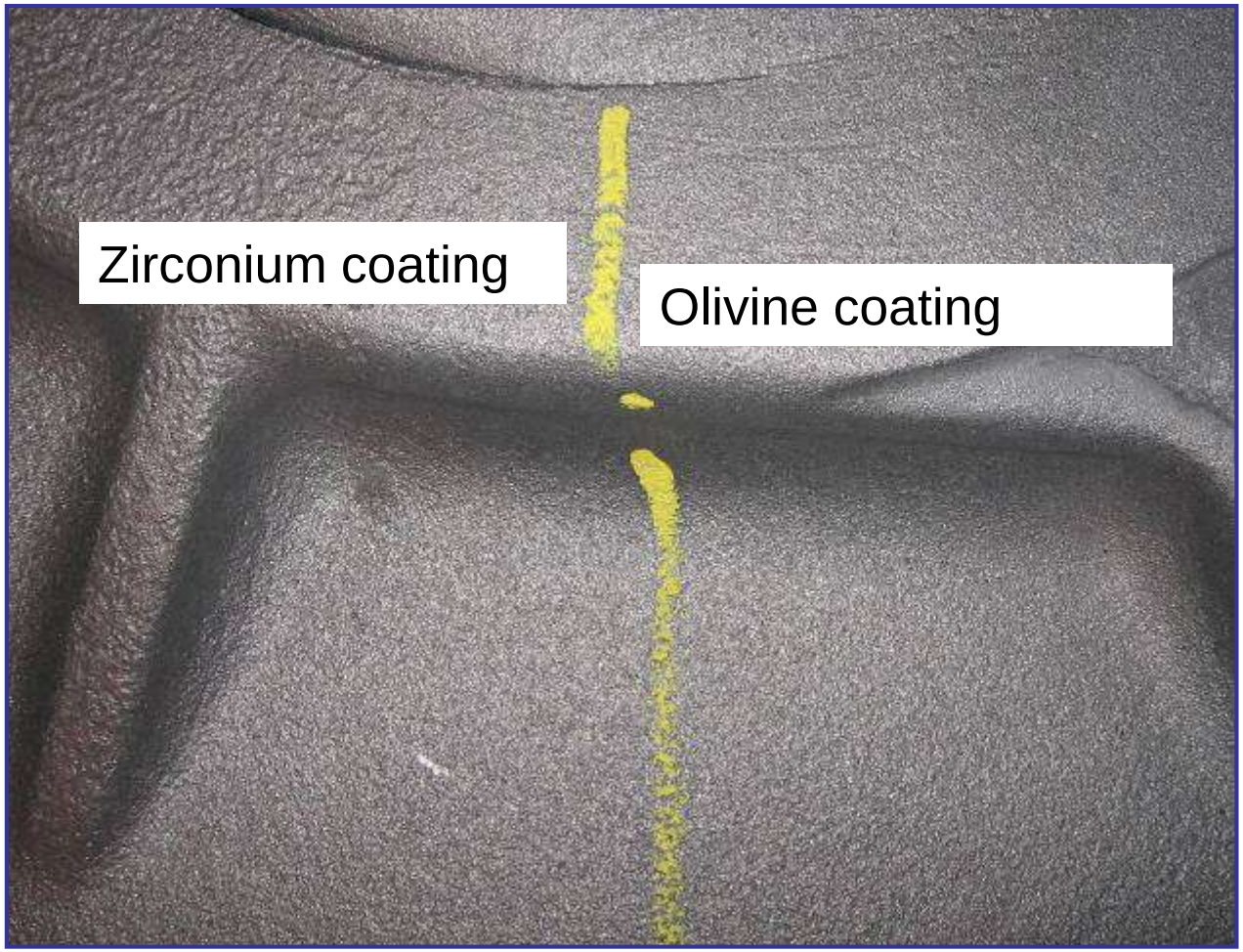
- Connection with Baur-Glässner-Diagram
  - Iron oxidations to FeO control by the $CO\text{-}CO_2$-equation



Formation of holes

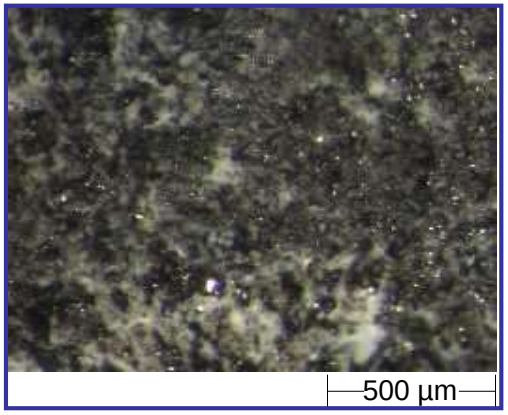
- Defect can be avoid by iron oxide containing additives instead of woodflour additives -> influence on the atmospheres
- Application of a coating with high gas permeability

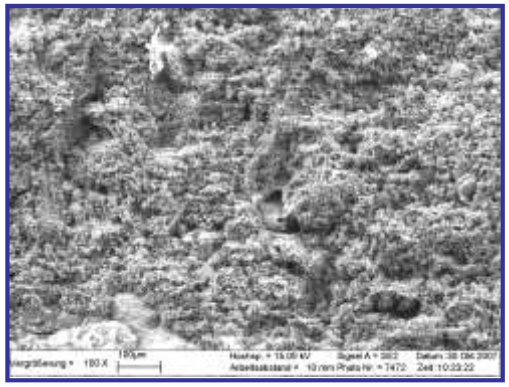
Scarred surface

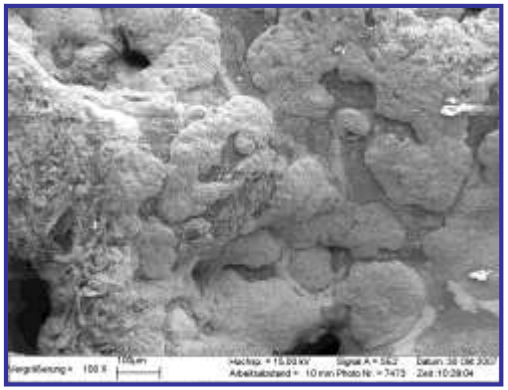


White and black surface

- White surface
  - Oxide melt
  - high Si- and O-content => SiO_2
  - less Fe-Oxides
  - C-inclusions



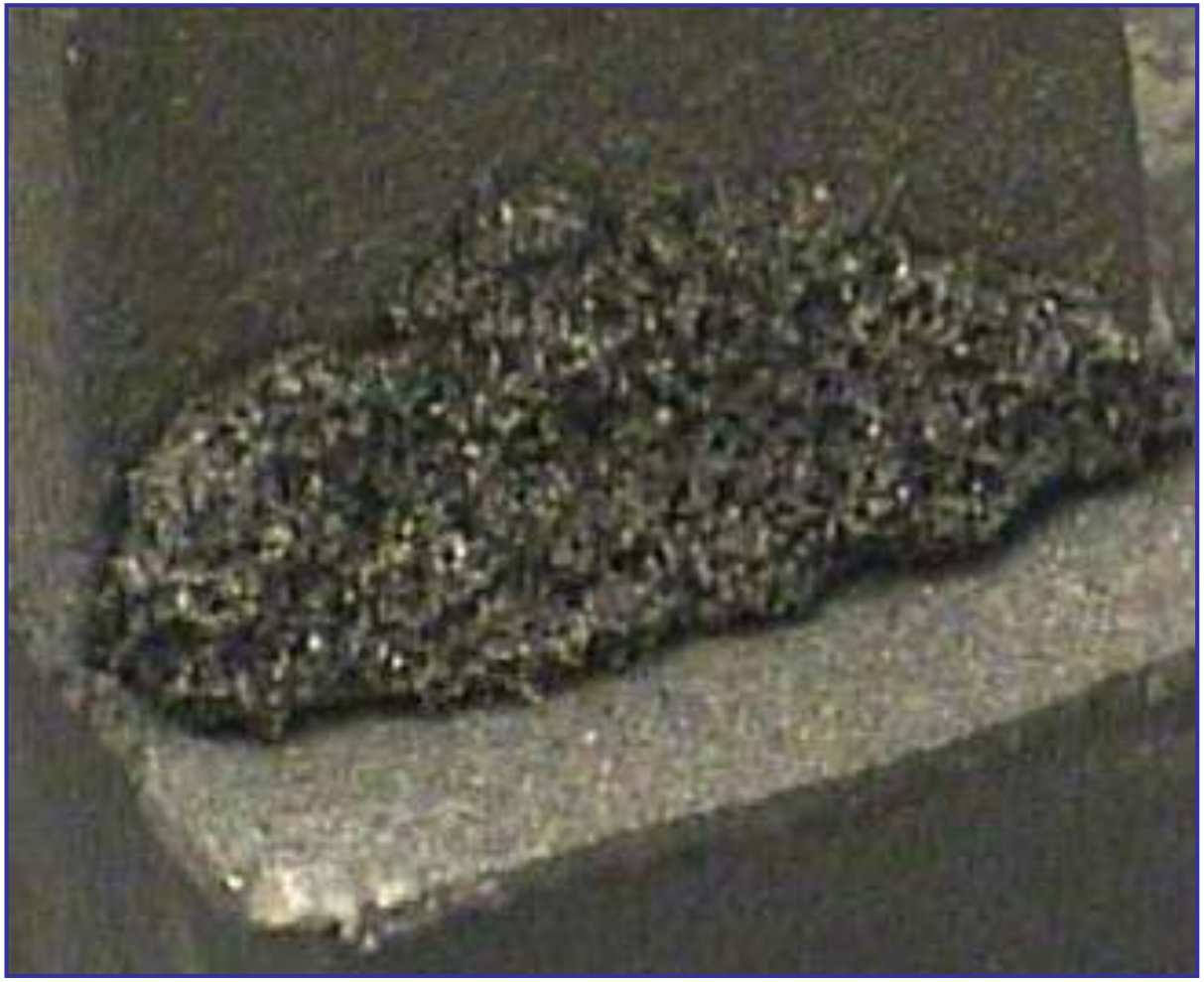




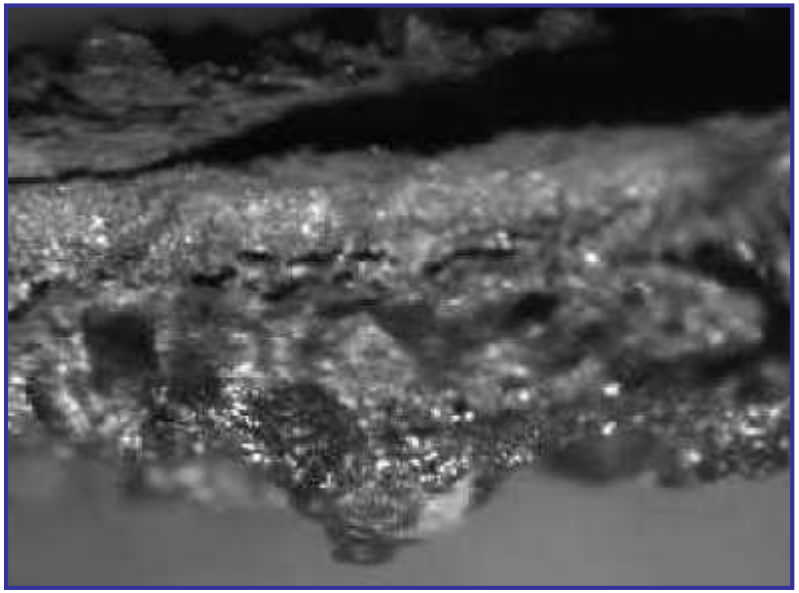
- Black surface
  - Mainly FeO
  - Lower Si- and O-content
  - Melting point degradation

Reaction of chromite sand in steel castings

Steel casting: chromite sand

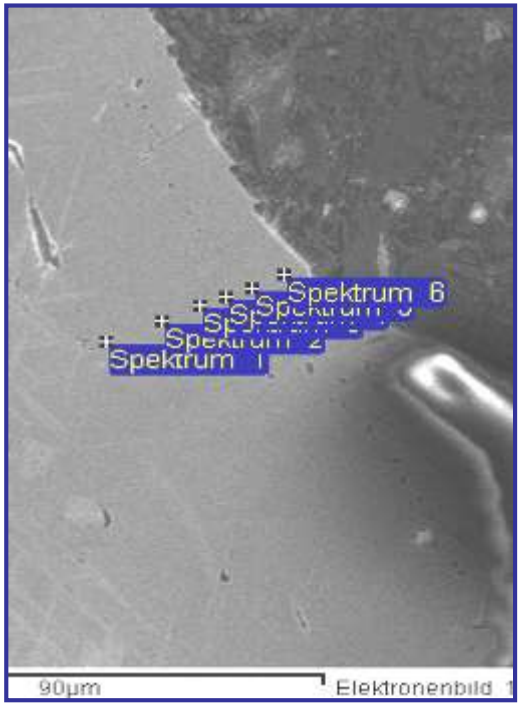


Steel casting: chromite sand



Chromite sand after annealing at 1500°C 0,5h in air

	Spektrum	Mg	Al	Cr	Fe
inside	Spektrum 1	7,63	5,13	32,55	26,29
	Spektrum 2	7,77	5,74	24,06	34,57
	Spektrum 3	7,92	6,42	20,72	37,61
	Spektrum 4	7,77	6,37	19,64	39,29
	Spektrum 5	7,58	5,85	18,65	41,49
outside	Spektrum 6	7,70	5,89	19,42	39,56



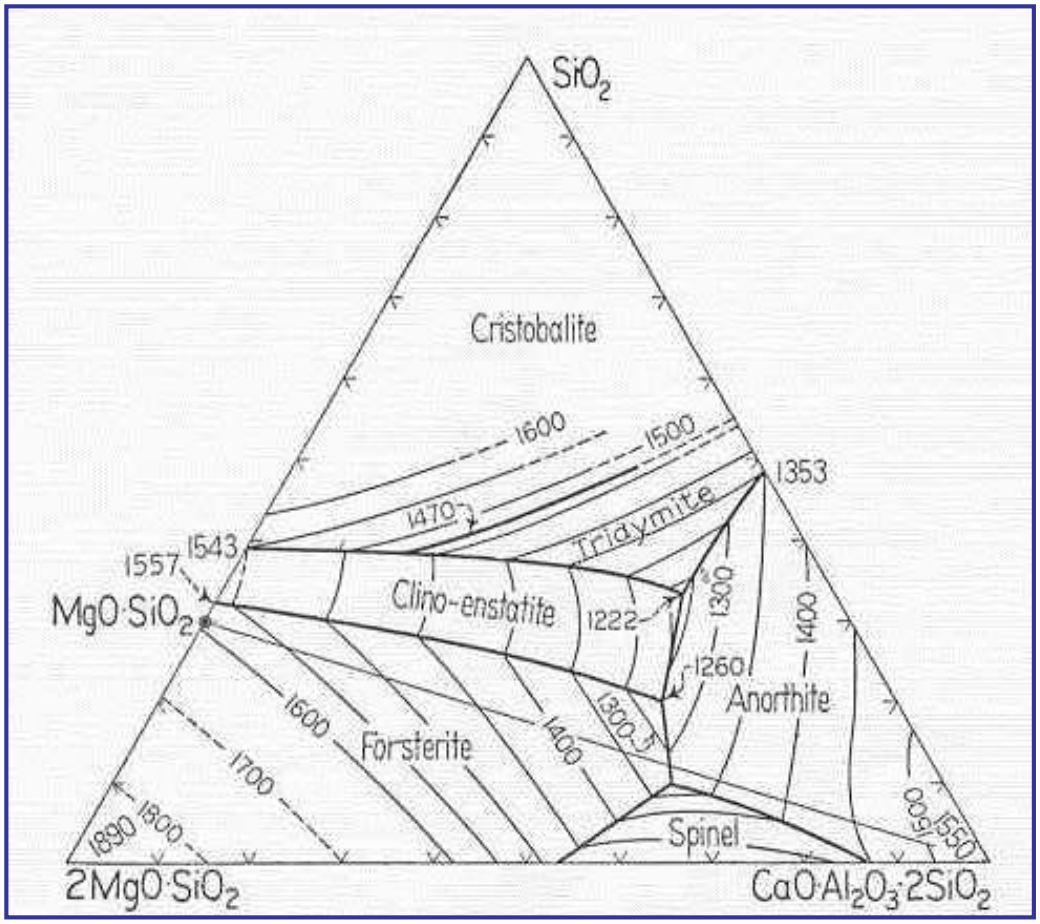
Steel casting: chromite sand

Steel casting: chromite sand

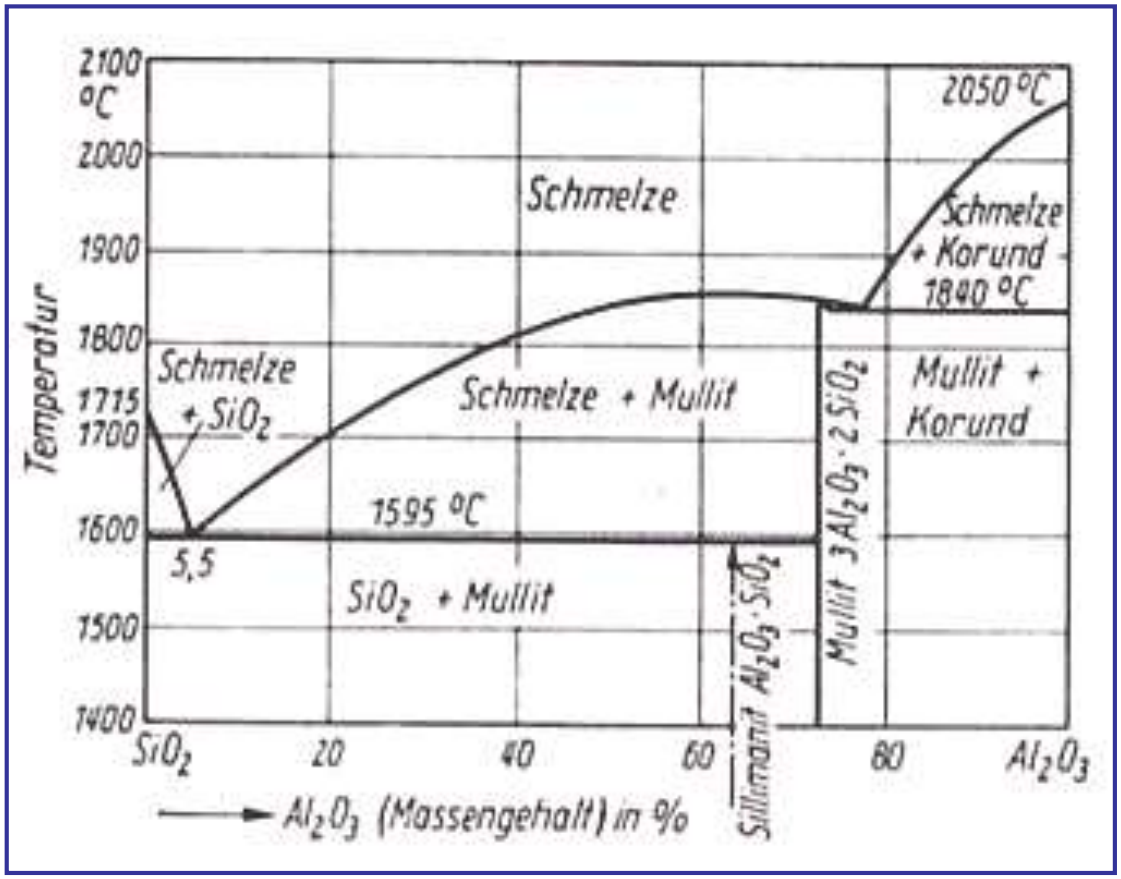
- Melting point Diopsid: 1392 °C
- Melting point Anortith: 1553 °C

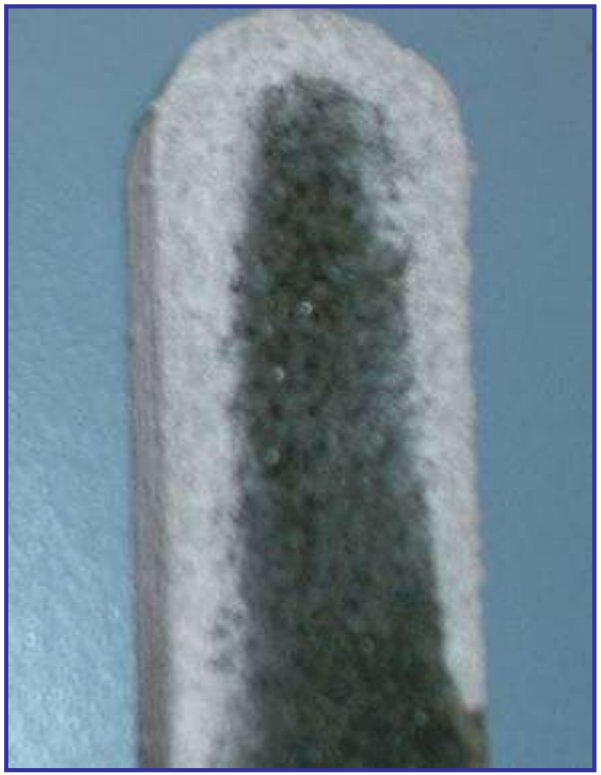
- Melting point of mixture Diopsid + Anortith:
- **1274 °C**

Steel casting: chromite sand



Steel casting: chromite sand





Silico L 200 A

Summary

- The right coating can prevent metallurgical defects or can create them by purpose
- Reaction defects in GJS can be avoided or suppressed with the right coating, that controls the causal creation of reaction gases
- Reaction of the coating with low quality chromite sand can increase the refractoriness and avoid unwanted defects