Zinc and Zinc-Alloys for General Galvanizing

- Boliden answers -

Nordic Galvanizers

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Kokkola

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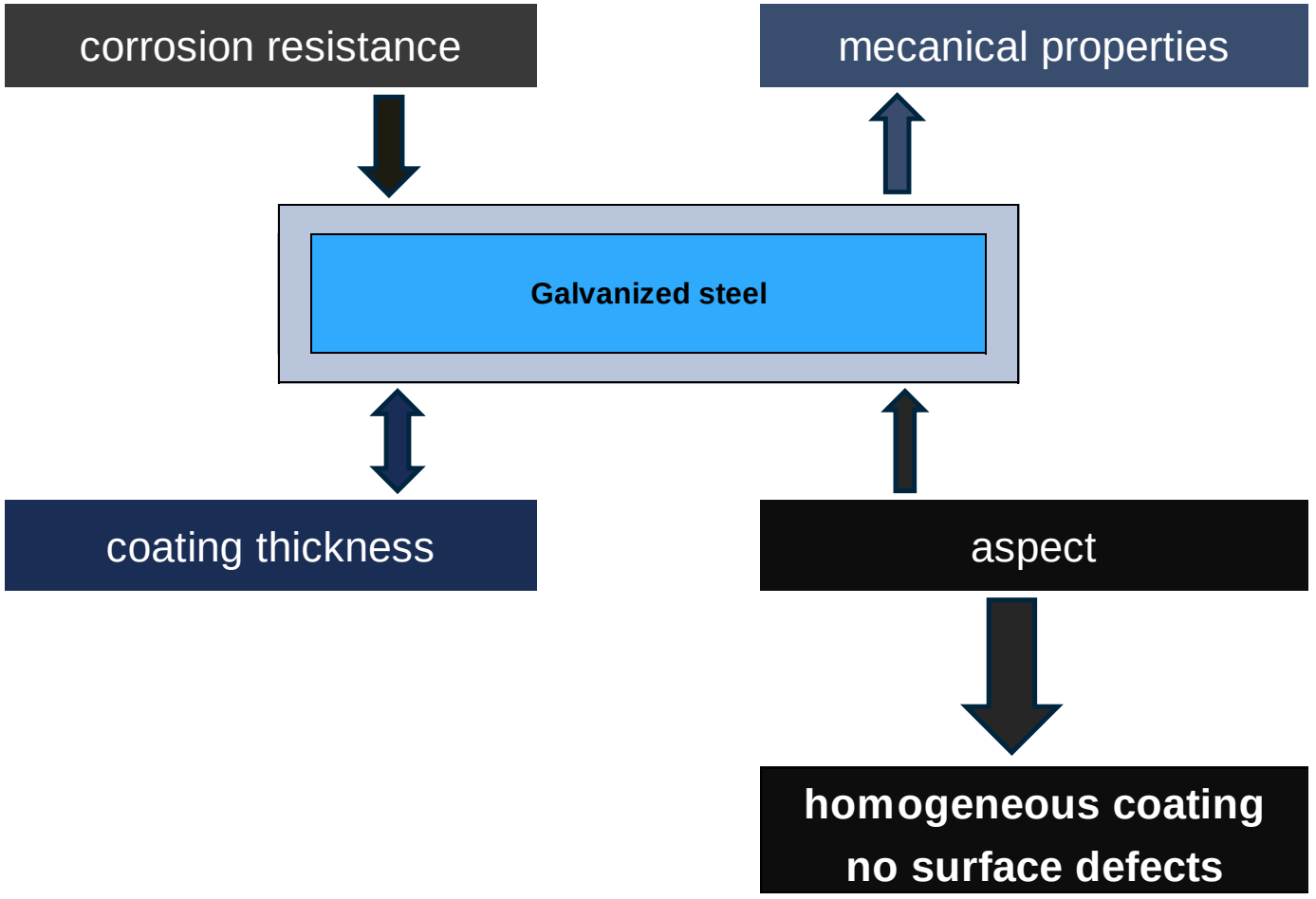
Content

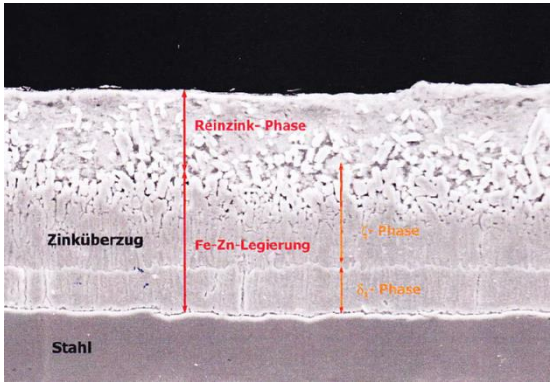
- **Requirements for GG steel**
- **Anomalies and defects**
  - **Related to Fe-Zn-reaction**
  - **Related to Pre-treatment and Zn-alloy-composition**
- **Influence of alloying Elements on Fe-Zn-reaction**
- **Influence of alloying elements on physical properties of the Zn-melt**
- **Boliden alloys**
  - **Special features**

Requirements on galvanized steel



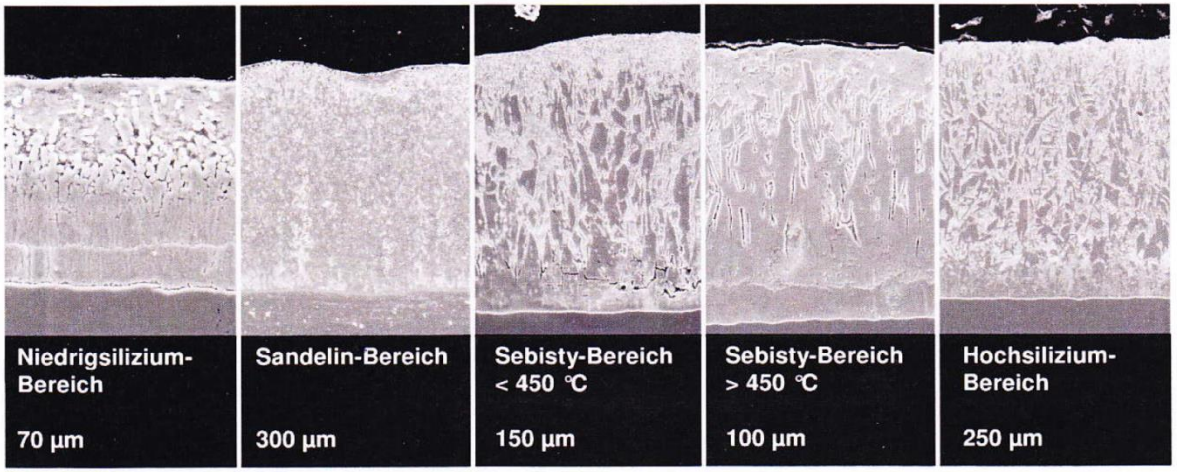
Homogeneous coating thickness; but how?

Perfect coating:



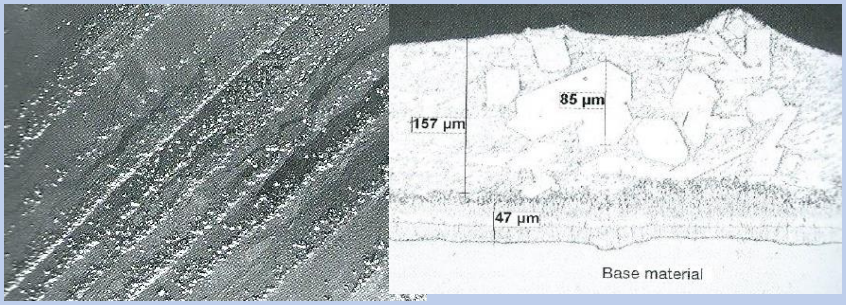
… steel composition

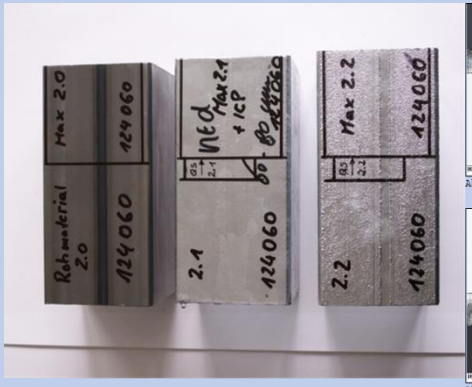
Typical coating structures at normal galvanizing temperatures

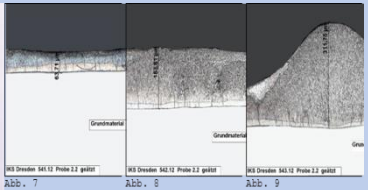


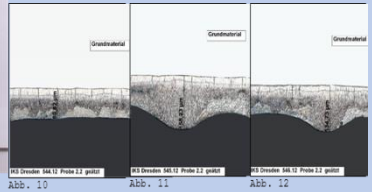
Galvanizing defects

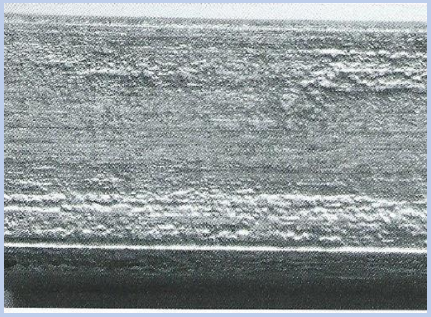
- … related to Zn-Fe-reaction

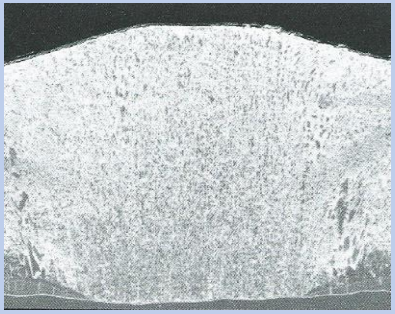




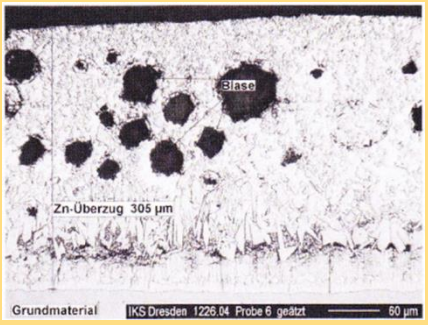


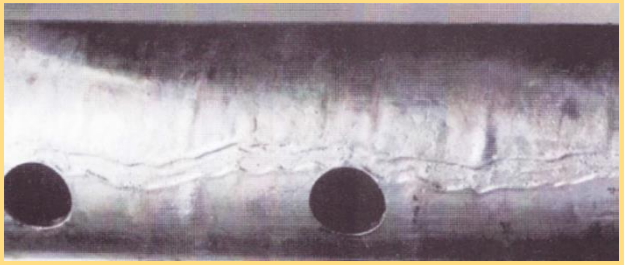




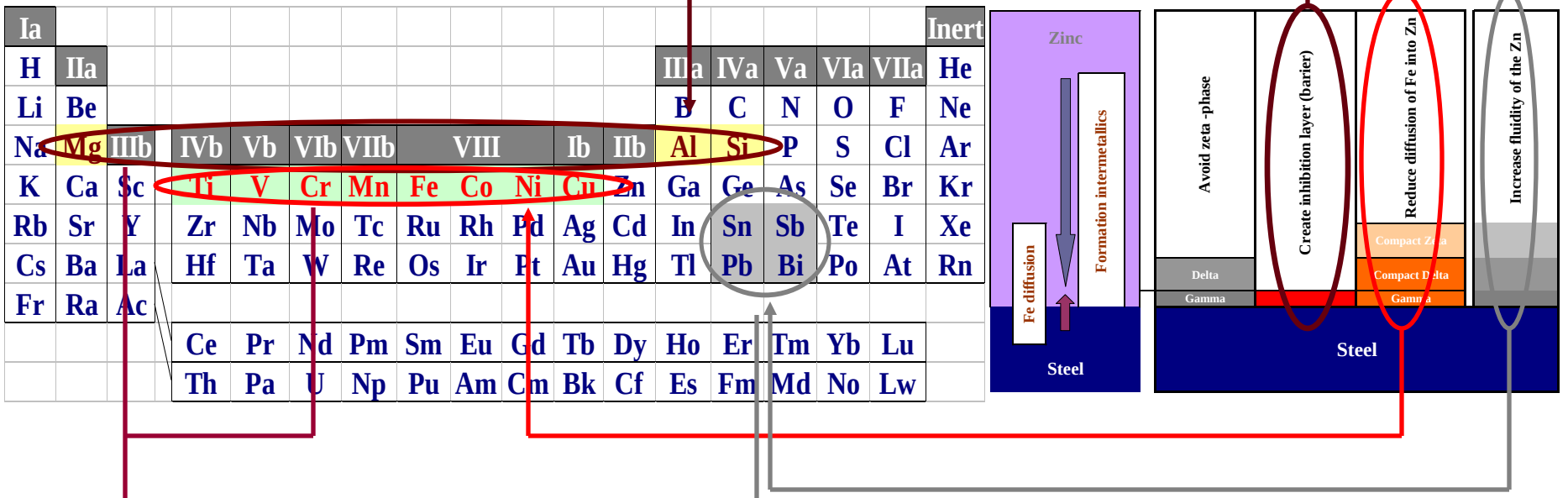


- Related to pre-treatment and physical properties of the Zn





Bath Chemistry
coating thickness control and physical properties Zn-melt

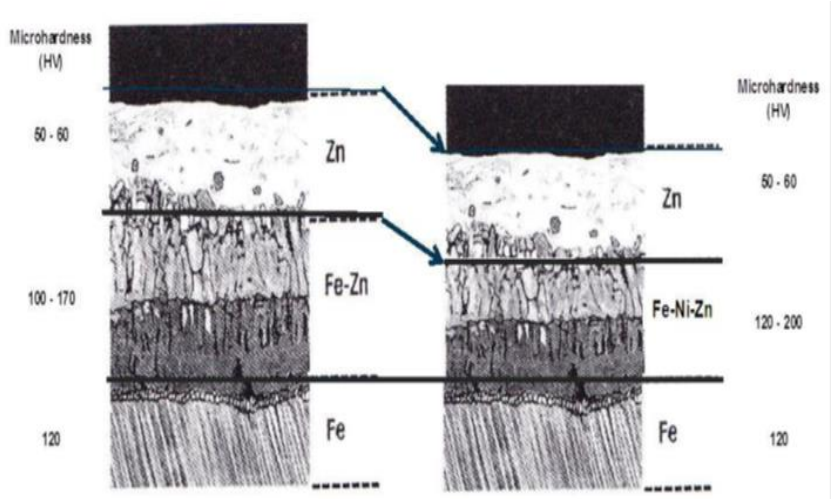


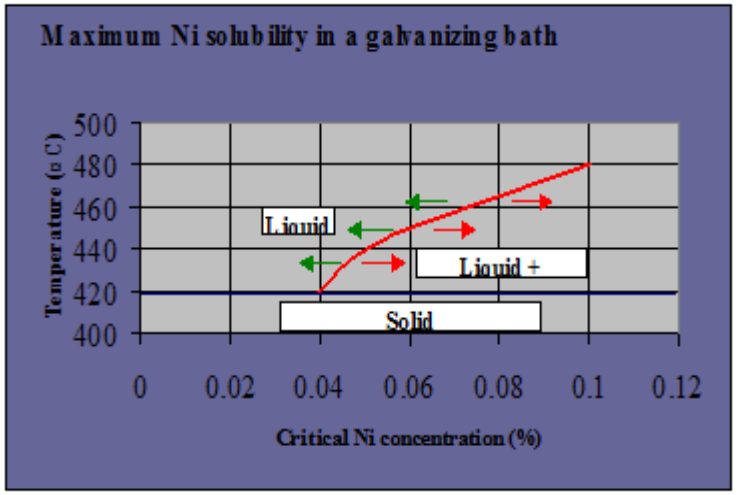
Elements influencing Fe-solubility in liquid Zinc

Elements not influencing Fe-solubility in liquid Zinc

but influencing the physical properties of liquid Zn

Reduce diffusion of Fe into Zn-melt …. By Ni-additions into the bath

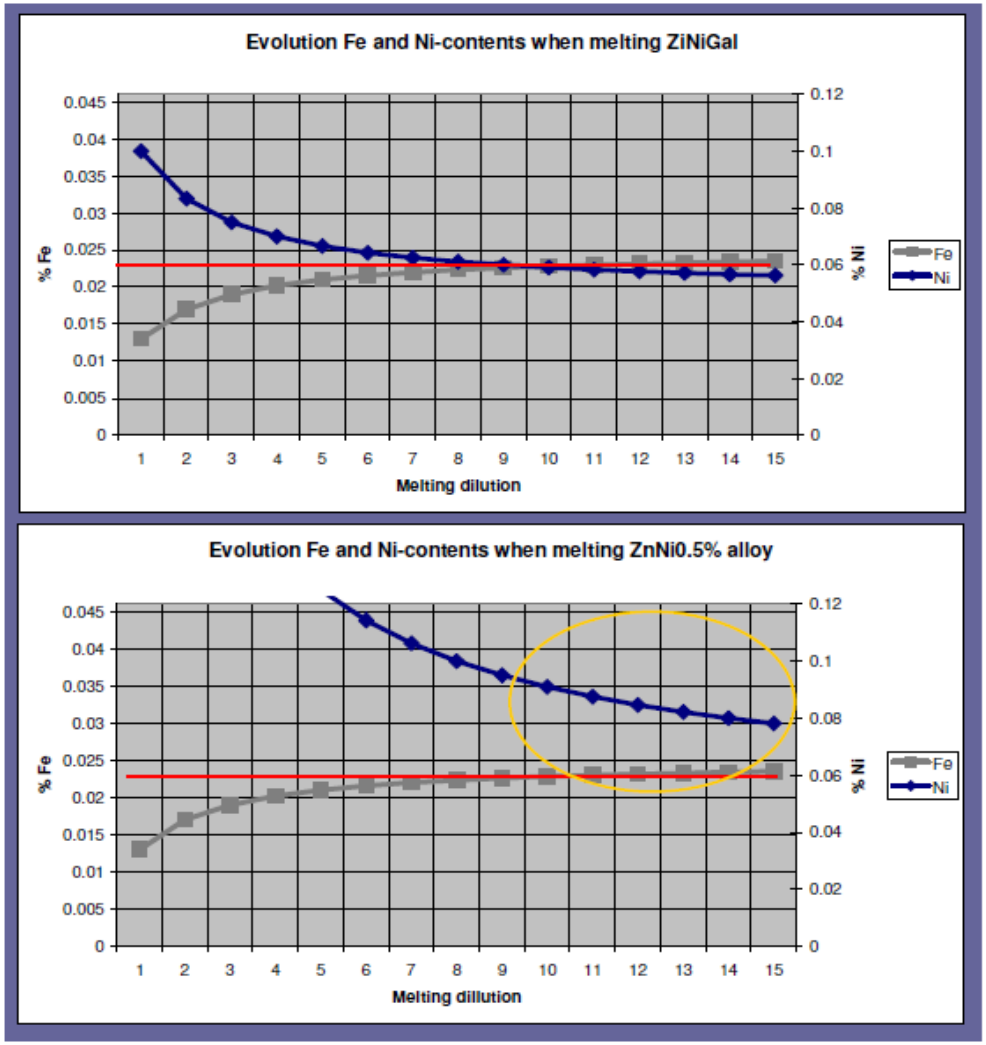




- Zn-Fe intermetallics will be Zn-Fe-Ni intermetallics
- In the coating Ni content has to be 0,10 – 0,14%!
- Those intermetallics will be harder and more compact
- This results in lower coating thickness
- Pure Zn-layer will only be slightly reduced

- Max concentration to be avoided
  otherwise Γ_2 precipitations (=pimples)
- Keep Ni-concentration and temperature stable
  otherwise pimples

Advantage to use Bolidens tailor-made ZiNiGal
Simulation of ingot melting



Criterias to avoid Γ2-precipitations (450 °C)

Ni < 0.06%

Fe < 0.023%

When melting ZiNiGal0.15 % those both conditions are not met

When dissolving Master-alloys, some risks to precipitate Γ2

Delay Zn-Fe reaction by Al-additions

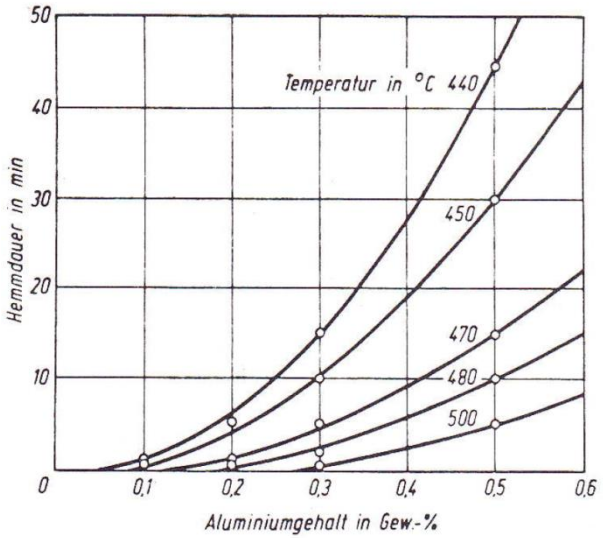


Abb. 13: Abhängigkeit der Hemmdauer vom Aluminium

- **Al concentrations higher than 300 ppm finally are a solution for reactive steel galvanizing**
  - **due to the high affinity of Al versus Fe and the creation of (Fe2Al5)- inhibition layers (limited time)**
  - **bad wettability demands efforts in pre-treatment (flux, dryer)**

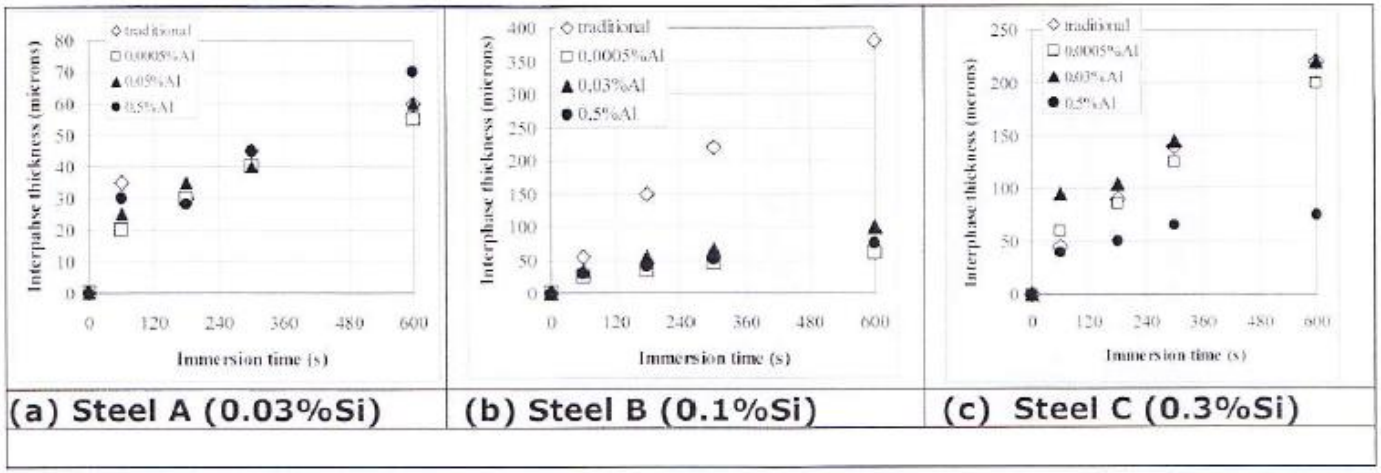


Figure 1 Zn-Al(0-0.5%) at 450°C.

Influence physical properties of liquid Zinc

Viskosity

- Describes drainage of liquids
- Viscosity is the opposite of fluidity
- Values only above melting temperature
- Viscosity drops with increasing temperature
  - Oxydation
  - Contaminations

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Surface tension

Surface tension is the elastic tendency of a fluid surface which makes it acquire the lowest surface area possible

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Wetting behavior

- Neither viscosity, nor surface tension can describe the wetting-behavior
- Wetting behavior depends on:
  - Surface
    - Cleanliness
    - Rugosity
  - Steel reactivity
    - reactive steels (high Si show better wetting behavior)

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- Physical properties are influenced by.
  - Pb (traditional)
  - Bi
  - Sn
  - Sb

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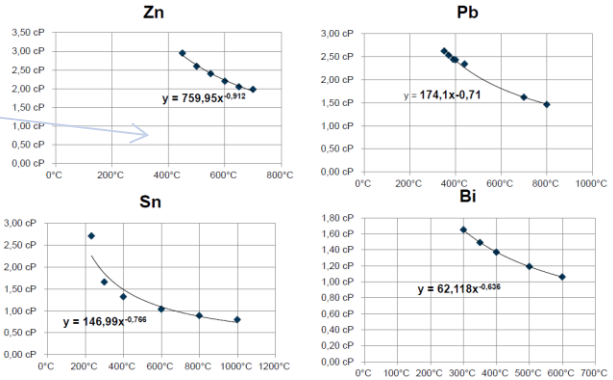
Influence Pb on coating physical properties of the Zn-melt

- **Viscosity**
  - **Describes drainage of Zn**

    Pb-equivalent (%) = Pb +Sn + 0,7Bi

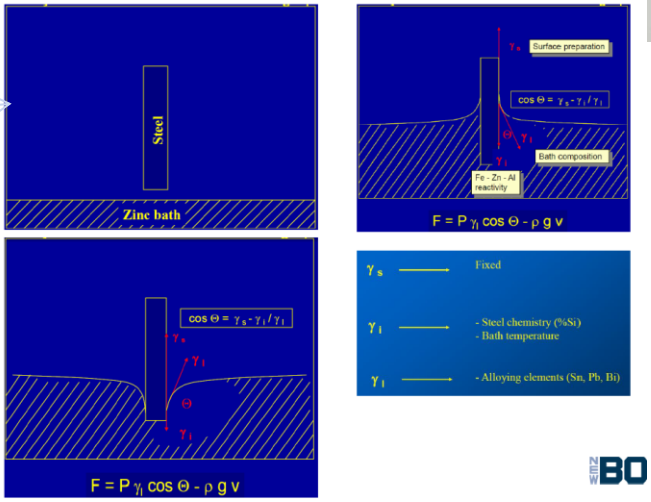


- **Surface tension**
  - **Low surface tension reduces surface defects**

    Pb-equivalent (%) = Pb +6 Bi + 0,15 Sn

- **Wettability**
  - **Describes suitability for galvanizing**

    Pb-equivalent (%)= Pb + 2 Bi + 3 Sn



Influence alloying elements on coating defects

Restrictions through standards

- **ISO 1461**

In Europe, the bath composition is defined in ISO 1461.
This standard requests the Zn-bath to have a composition with > 98,5 % Zn

- **DASt-guideline**

Zinkbad-Klasse (Stan-dard)	Zinkschmelzanteile (Gew.-%)				
	Sn	Pb + 10 Bi	Ni	Al	Summe weiterer Elemente (ohne Zn)
1	≤ 0,1	≤ 1,5	< 0,1	< 0,1	< 0,1

Therefore restrictions in amounts of Bi and Sn!

Bolidens Alloys for General galvanizing

	Composition alloy				
	Zn	Ni	Bi	Sn	Al
SHG	100,00				
ZiNiGal	99,85	0,15			
ZiNiGal-light	99,88	0,12			
ZiNiGal-plus	99,80	0,15	0,05		
ZiNiGal-light-plus	99,83	0,12	0,05		
ZiNiGal-bright	99,75	0,15	0,05	0,05	
ZiNiGal-light-bright	99,78	0,12	0,05	0,05	
ZnNi-Masteralloy-plus	99,50	0,50			
ZnNi-Masteralloy	99,35	0,50	0,15		
Zinkal5	95,00				5,00
Zinkal10	90,00				10,00

Composition bath		
Ni	Bi	Sn
0,05		
0,04		
0,05	0,10	
0,04	0,10	
0,05	0,10	0,10
0,04	0,10	0,10