Introduction into powder coatings

Introduction into powder coatings

- Polymerisation
- Chemistries
  - chemical reaction
  - advantage/disadvantages
- Application
- Melting/Curing process
- Matting

Two types of Polymerisation processes

- Addition polymerisation

  -A polymerization in which the growth of polymer chains proceeds by addition reactions between molecules of all degrees of polymerization (e.g. acrylics)

- Condensation polymerisation

  - A polymerization in which the growth of polymer chains proceeds by condenstation reactions between molecules of all degrees of polymerization with loss of small molecules like water. (e.g. polyesters)

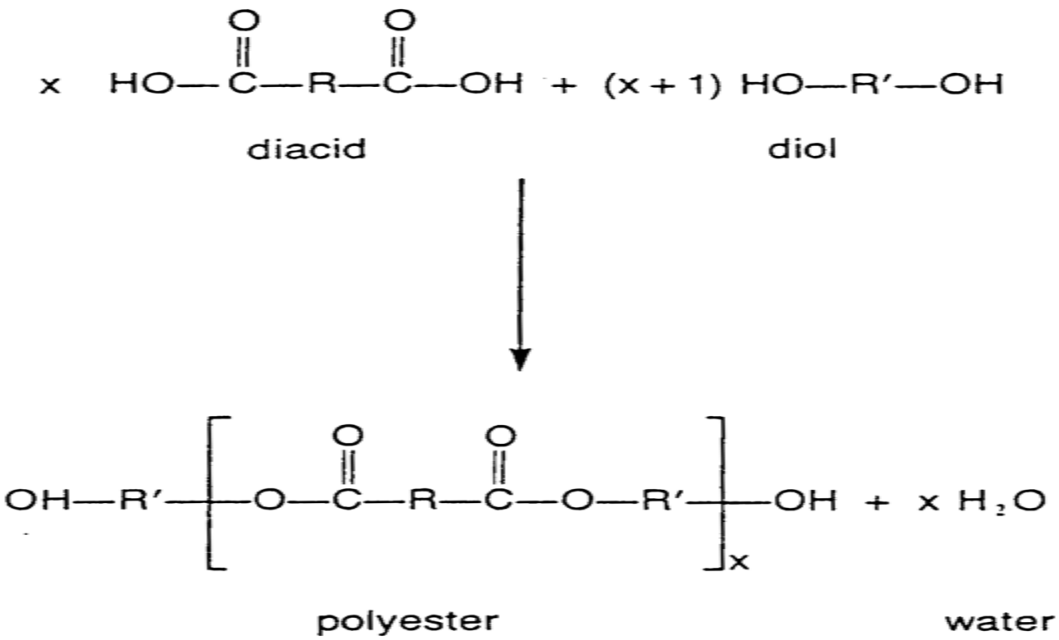
Raw materials

- **Diols (glycols)**
  - Neopentylglycol
  - Ethyleneglycol
  - propyleneglycol-1,2
- **Polyalcohols**
  - Trimethylolpropane
  - glycerol
- **Dicarboxylic acids**
  - terephthalic acid
  - isophthalic acid
- **Polycarboxylic acids**
  - trimellitic anhydride

Esterification

- **Esterification**:
  - Acid + Alcohol → Ester + Water
  - Polyacid + Polyalcohol → Polyester + Water
- **Hydrolysis**:
  - Polyester + Water → Polyacid + Polyalcohol
- **Overall**:
  - Polyacid + Polyalcohol → Polyester + Water

Main reaction



Excess of OH	OH-functional polyester
Excess of COOH	COOH-functional polyester

Powder Coating Formulation

- Resin (polyester)
- Crosslinker
- Pigments / Fillers
- Flow agents
- Degassing agents
- Catalysts

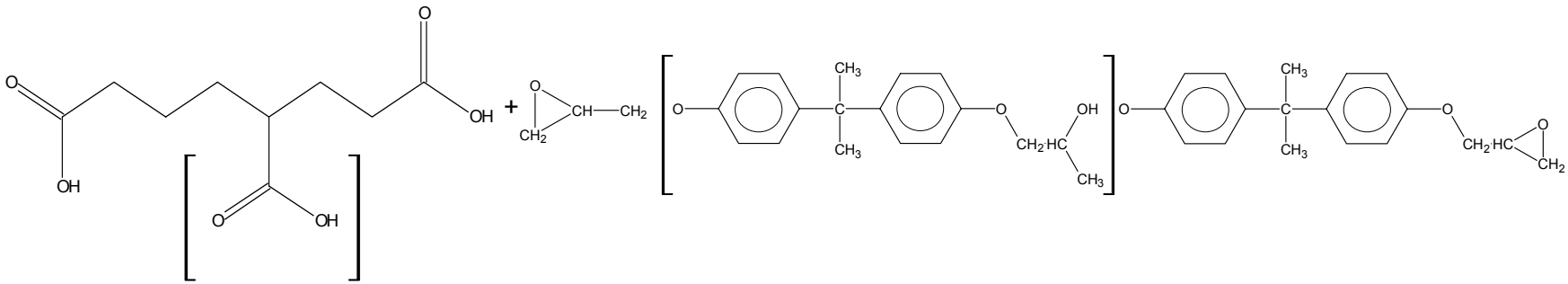
Chemistries (Binder systems)

• Interior (hybrid)	• bisphenol A epoxies	• Carboxylic polyester
• Exterior	• Araldite PT 810 (TGIC) • Primid XL 552 / QM 1260 • Araldite PT 910 • Mix crosslinker • Uranox	• Carboxylic polyester
	• (blocked) Isocyanates • glycoluril	• Hydroxyl polyester

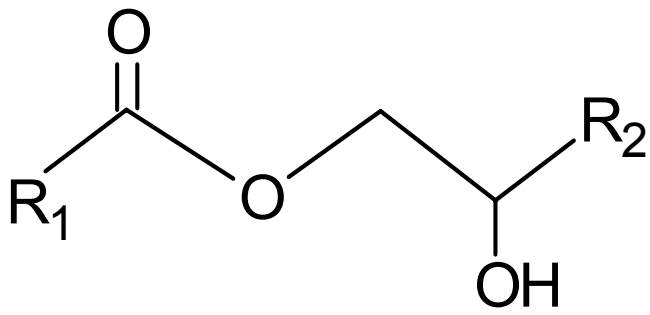
Overview of the characteristics of binder systems

	Polyester / Epoxy	Polyester / TGIC	Polyester / Primid	Polyester / PT 910	Uranox	Uranox/ Primid	Polyester/ Isocyanate no split-off
Flexibility	++	++	++	++	++	++	++
Flow adjustability	++	++	++	++	+	++	++
Exterior durability	--	++	++	++	+	++	++
Powder stability	++	+	+	+/±	±	+	+
Colour stability - overbake - direct gas oven	 + +	 ++ ++	 + ±	 ++ ++	 ± +	 ± +	 + +
Processing	++	++	+	+	++	++	+/++
Split-off products	++	++	-	++	++	+	++
Blister-free layer thickness	++	++	-	++	++	+	+
Labelling	++	--	++	±	++	++	++

Hybrids



Carboxylated Polyester + Bisphenol A diglycidyl ethers



Hybrids

+ Advantages
- Price/performance
- Flexibility
- Large curing window
- Ease of processing
- Powder stability
- Chemical resistance

- Disadvantage
- Outdoor durability

Carboxyl Polyesters for Hybrids

Crosslinker: bisphenol A epoxies

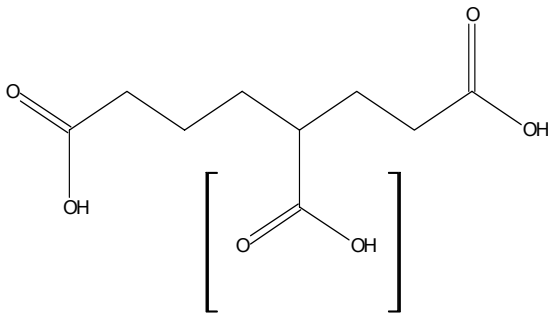
- 50/50 systems
- 60/40 systems
- 70/30 systems

- Acid value 70-85
- Acid value 48-55
- Acid value 32-38

Outdoor durable Crosslinkers

Araldite PT 810	Huntsman
XL 552 / QM 1260	EMS
PT 910/PT 912	Huntsman
Uranox	DSM Resins
BF 1540 / BF 1320	Creanova
LS 2147	Bayer

TGIC



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Carboxylated Polyester

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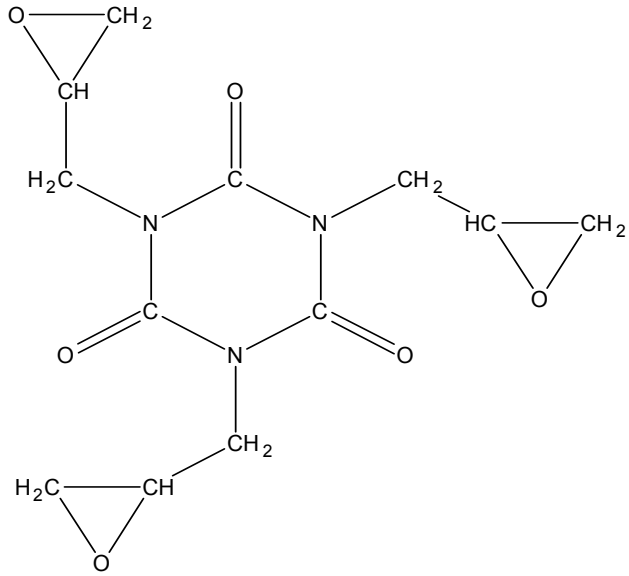
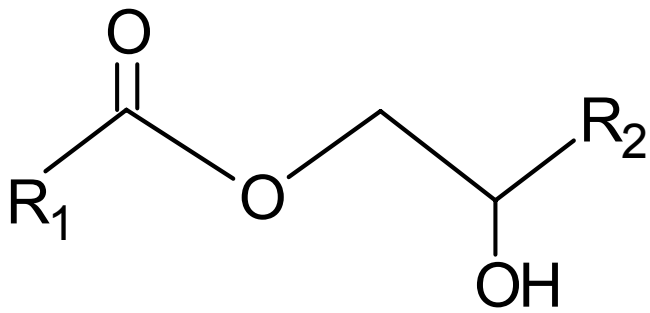
TGIC (triglycidylisocyanurate)



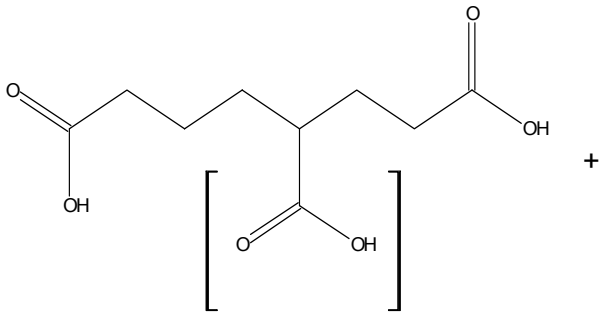


TGIC

+ Advantages
- Flexibility
- Large curing window
- Outdoor durability
- Colour stability
- Processing
- Powder stability

- Disadvantage
- Labeling

Primid (XL 552, QM 1260)



Carboxylated Polyester

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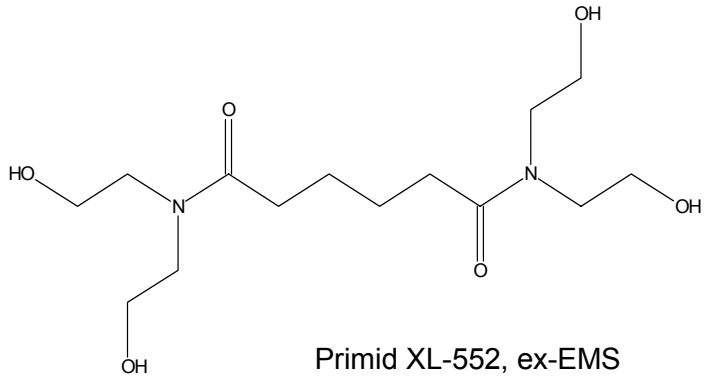
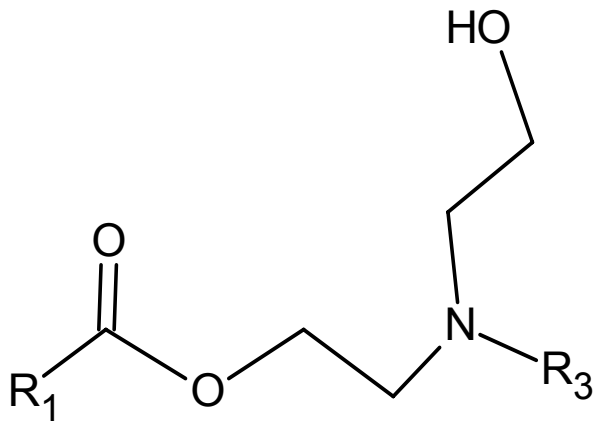


Primid XL-552, ex-EMS Primid

+



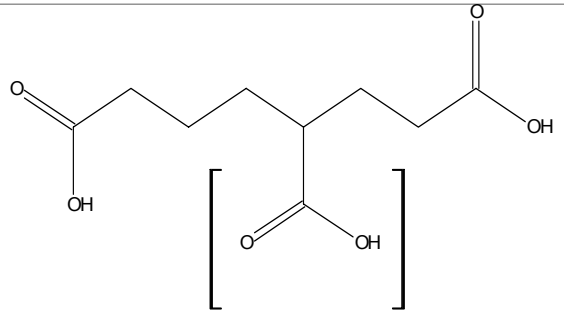
+ H_2O

Primid (XL 552, QM 1260)

+ Advantages
- Label free
- System cost
- Low curing temperatures
- Outdoor durability
- Powder stability

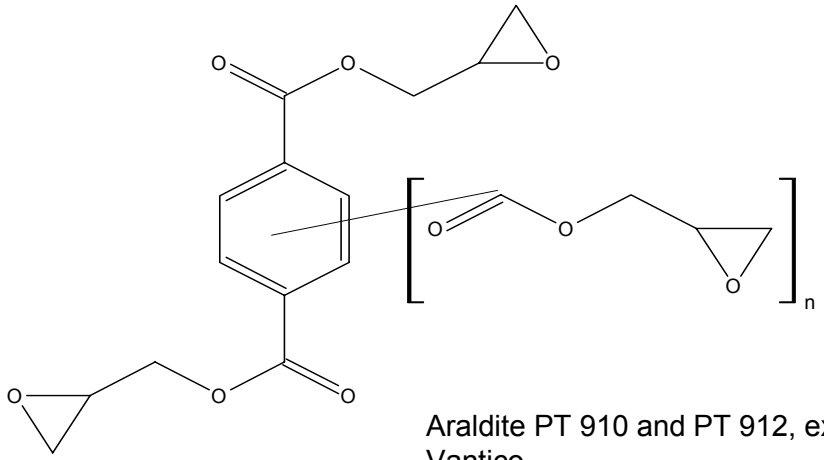
- Disadvantage
- Yellowing tendency
- Low blister-free layer thickness
- Water sensitivity
- Proces sensitivity

PT 910 (PT 912)



Carboxylated Polyester

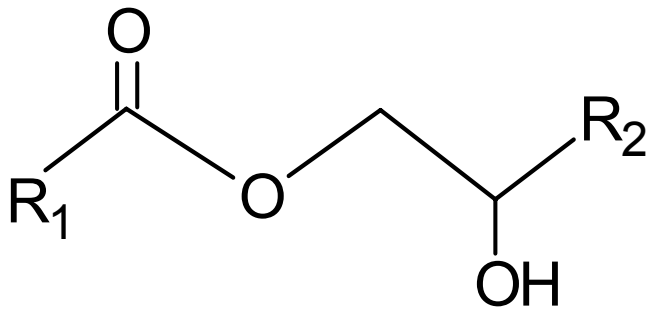
+



0<n<1

+

Araldite PT 910 and PT 912, ex-Vantico



PT 910 (PT 912)

+ Advantages
- Well-known chemistry
- Excelent exterior durability
- Thick layers
- Colour stability

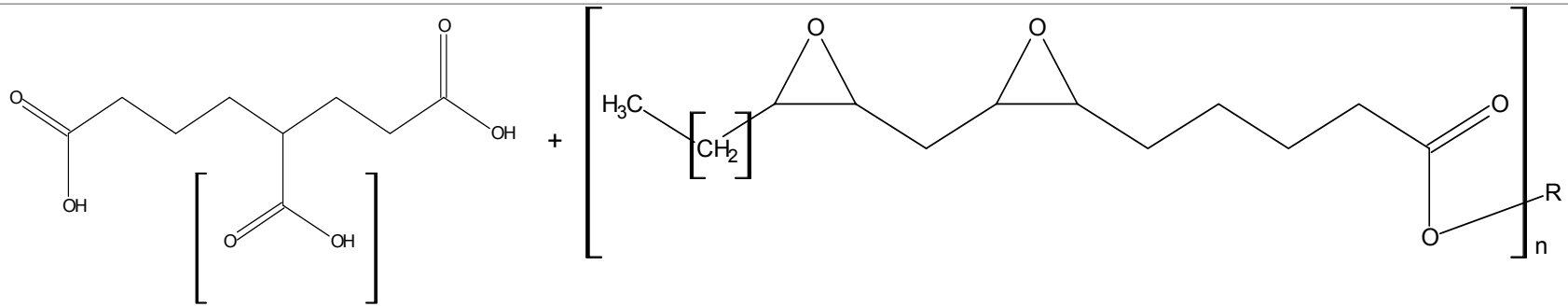
- Disadvantage
- Xi Labeling
- Lower cross-link density
- Processing sensitivity

Mixed cross linker

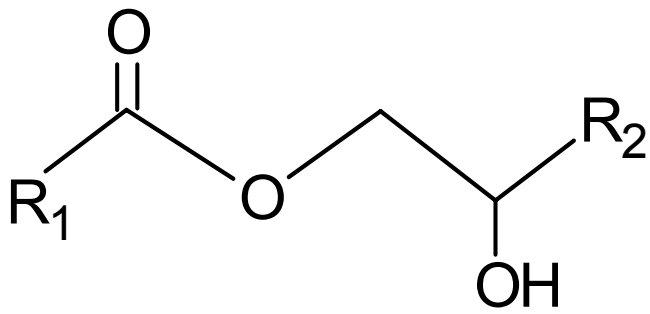
- Combination of carboxylated resin with 2 cross linkers

- e.g. PT 910/Primid
- Primid/Uranox

Uranox



Carboxylated Polyester + Uranox, ex-DSM Coating Resins



Uranox

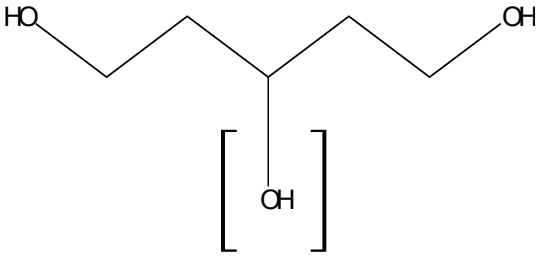
\+ Advantages

- No Hazard labelling
- Processing properties
- Pigment wetting

\- Disadvantage

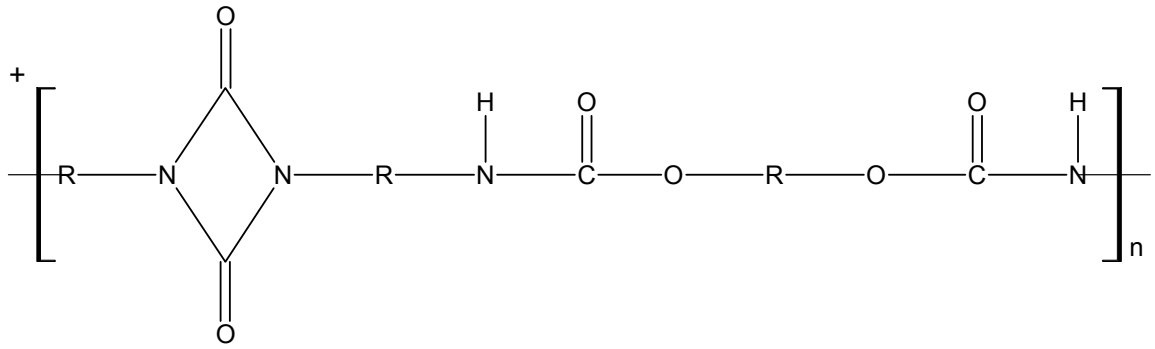
- Powder stability (P7200 and P 7300)
- Yellowing under extreme test conditions

Polyurethanes

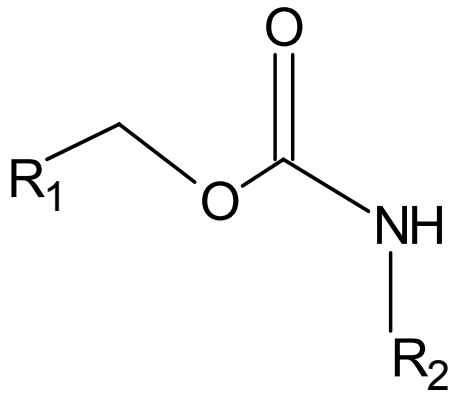


Hydroxylated polyester

\+



Internally blocked isocyanates



Polyurethanes

+ Advantages
- Outdoor durability
- Powder stability
- Flow
- Chemical resistance

- Disadvantage
- Price
- Caprolactam blocked types:
- Split-off products

Polyester/cross linker ratio (carboxylated resins)

- Equivalent weight polyester
- 56100 / AV = EW1

- Example: AV= 35
- 56100 / 35 = 1600

- Equivalent weight Cross-linker: EW2

- Primid XL 552: EW = 84

- Stoichiometric resin ratio:
- (EW1 / (EW1 + EW2))*100%

- (1600 / (1600 + 84))*100% =
- 95% Polyester
- 5% Primid XL 552

Polyester/cross linker ratio (Hydroxylated resins)

- - Equivalent weight polyester
- 56100 / HV = EW1

- Example: HV= 42
- 56100 / 42 = 1336

- - Equivalent weight Cross-linker: EW2

- BF 1540: EW = 280

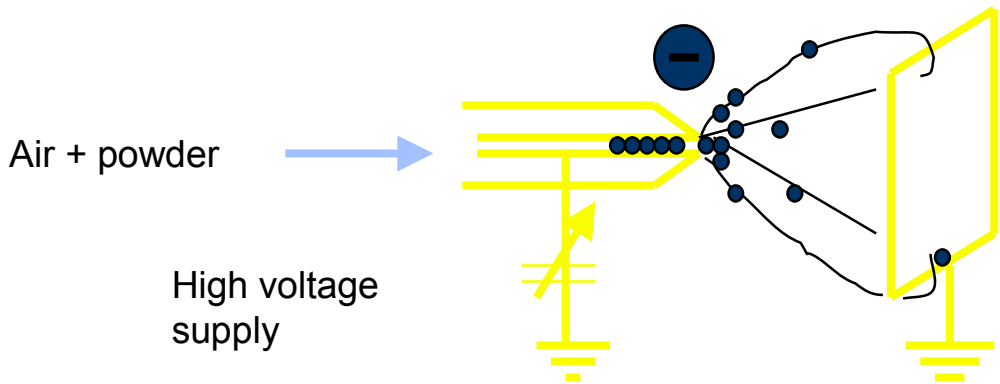
- Stoichiometric resin ratio:
- (EW1 / (EW1 + EW2))*100%

- (1336 / (1336 + 280))*100% =
- 82% Polyester
- 18% BF 1540

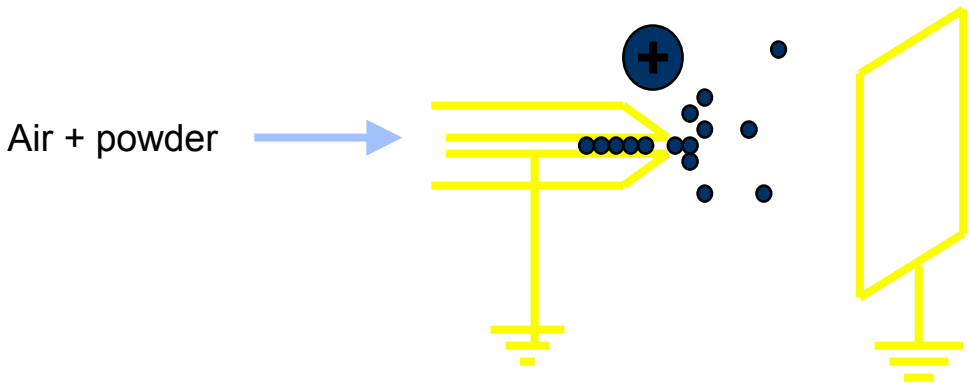
Polyester / crosslinker ratio several Acid values

		Ratio Polyester / crosslinker				
	EW	AV				
		20	28	35	53	80
Araldite GT 7004	700	80/20	75/25	70/30	60/40	50/50
Araldite PT 810 (TGIC)	110	96/4	95/5	**93/7**		
Primid XL 552	84	97/3	96/4	**95/5**	93/7	
Primid QM 1260	100	97/3	95/5	94/6	91/9	
Araldite PT 910	150		**93/7**	91/9		

Application



Corona



Tribo

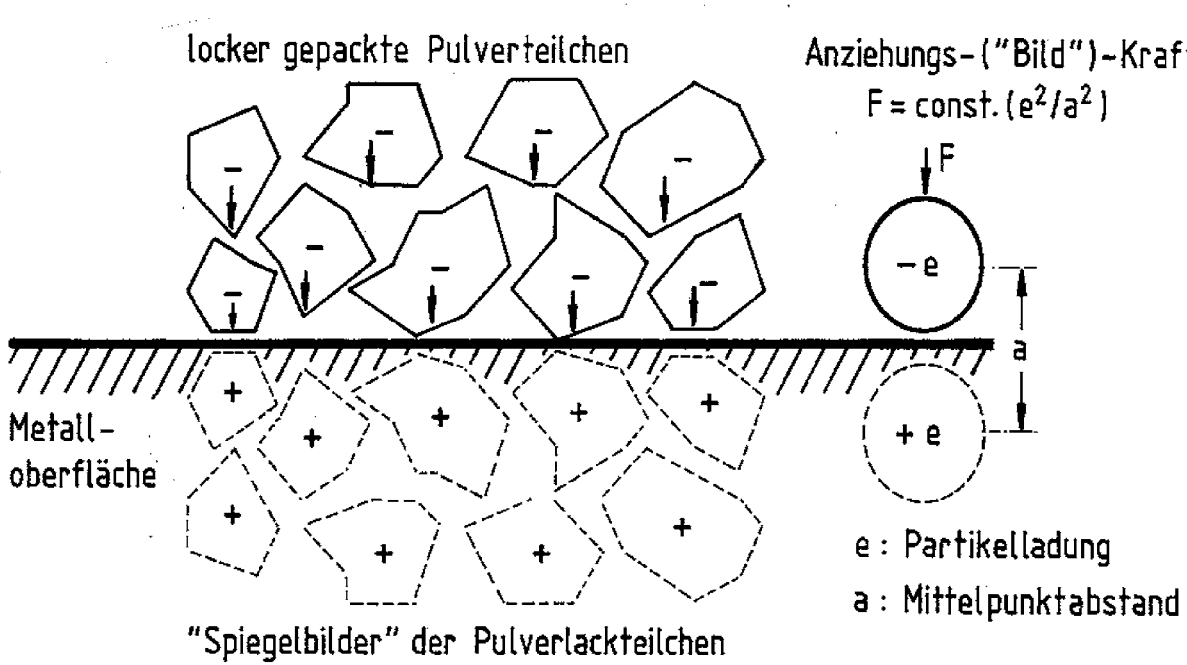
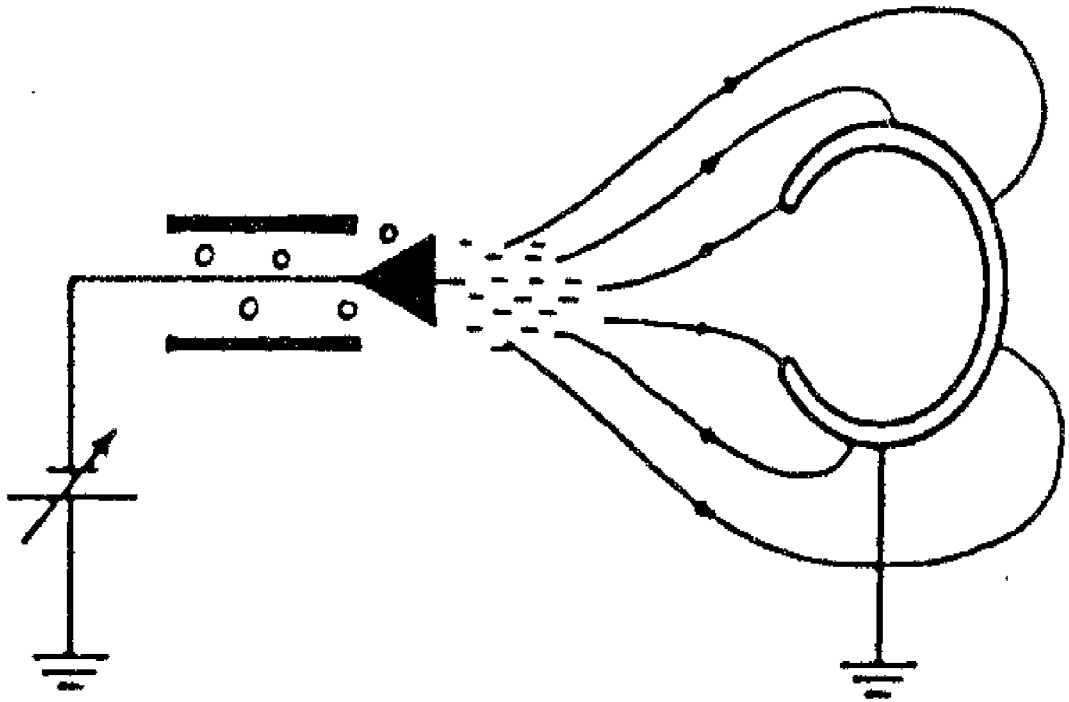
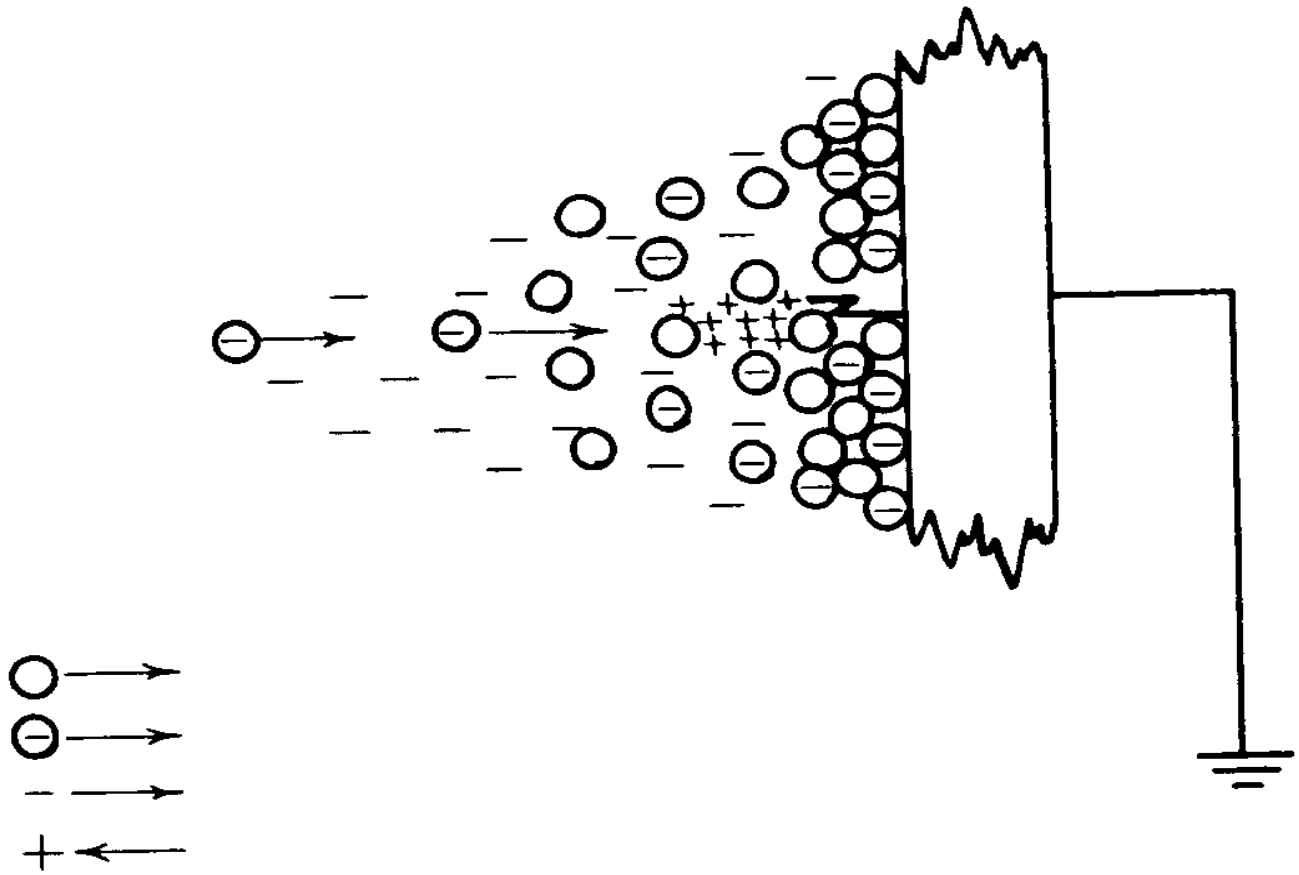


Abb. 7: Stabilisierung der abgeschiedenen Pulverlackschicht durch „Bildkraft"-Wirkung der Partikelladungen

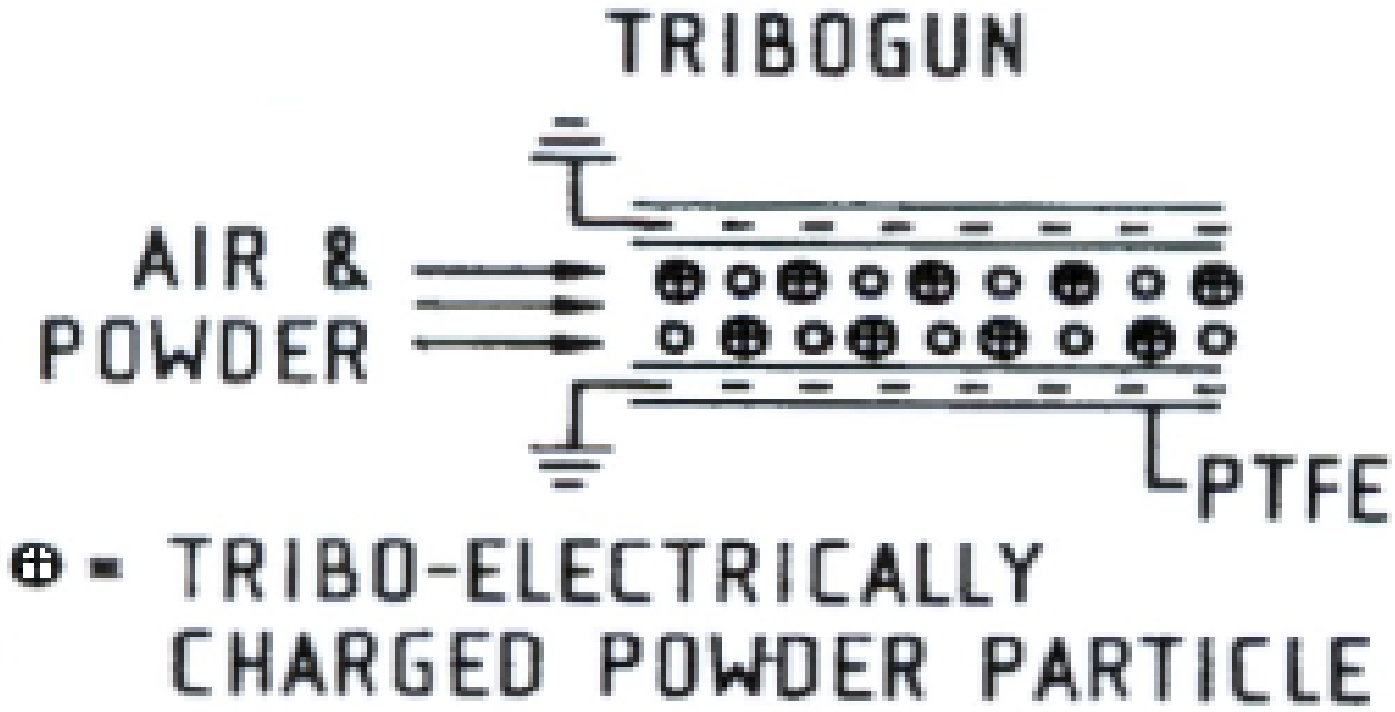
Corona Faraday cage



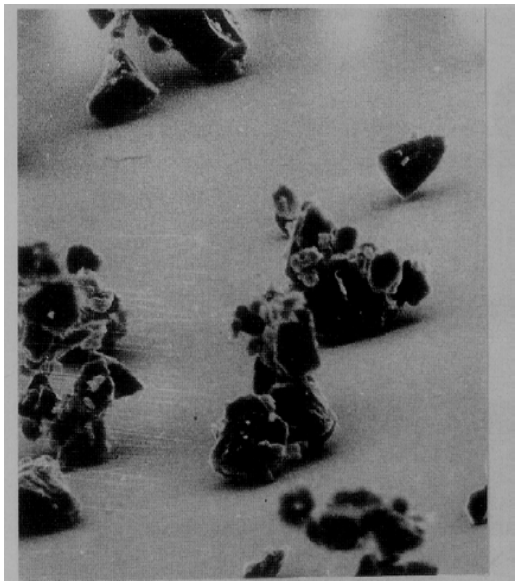
Corona Back ionisation

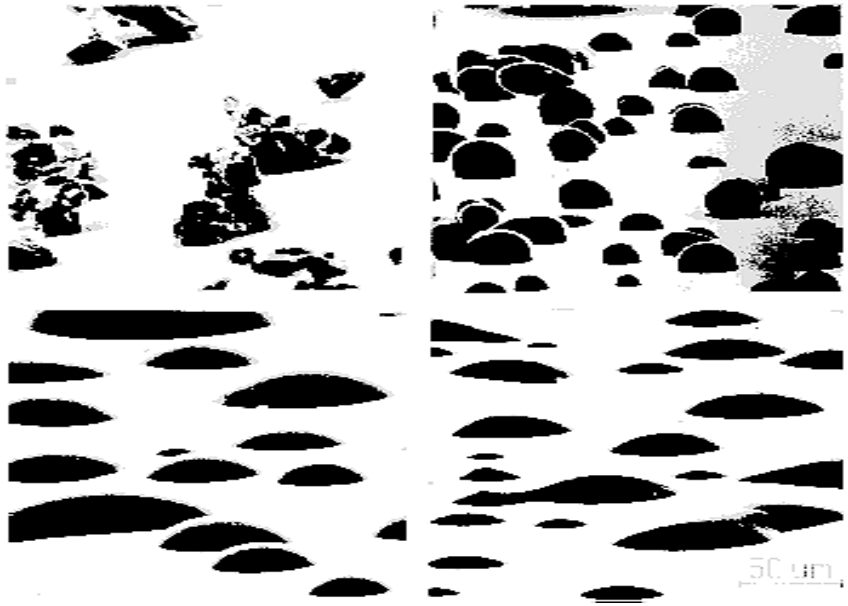


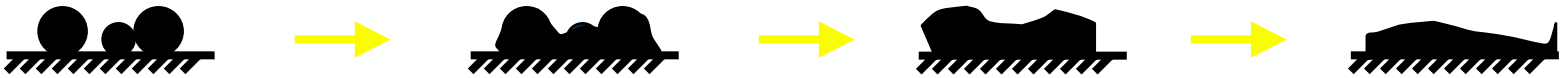
Tribo


TRIBOGUN
AIR &
POWDER
PTFE
⊕ = TRIBO-ELECTRICALLY
CHARGED POWDER PARTICLE

Melting / curing proces melt cure stages







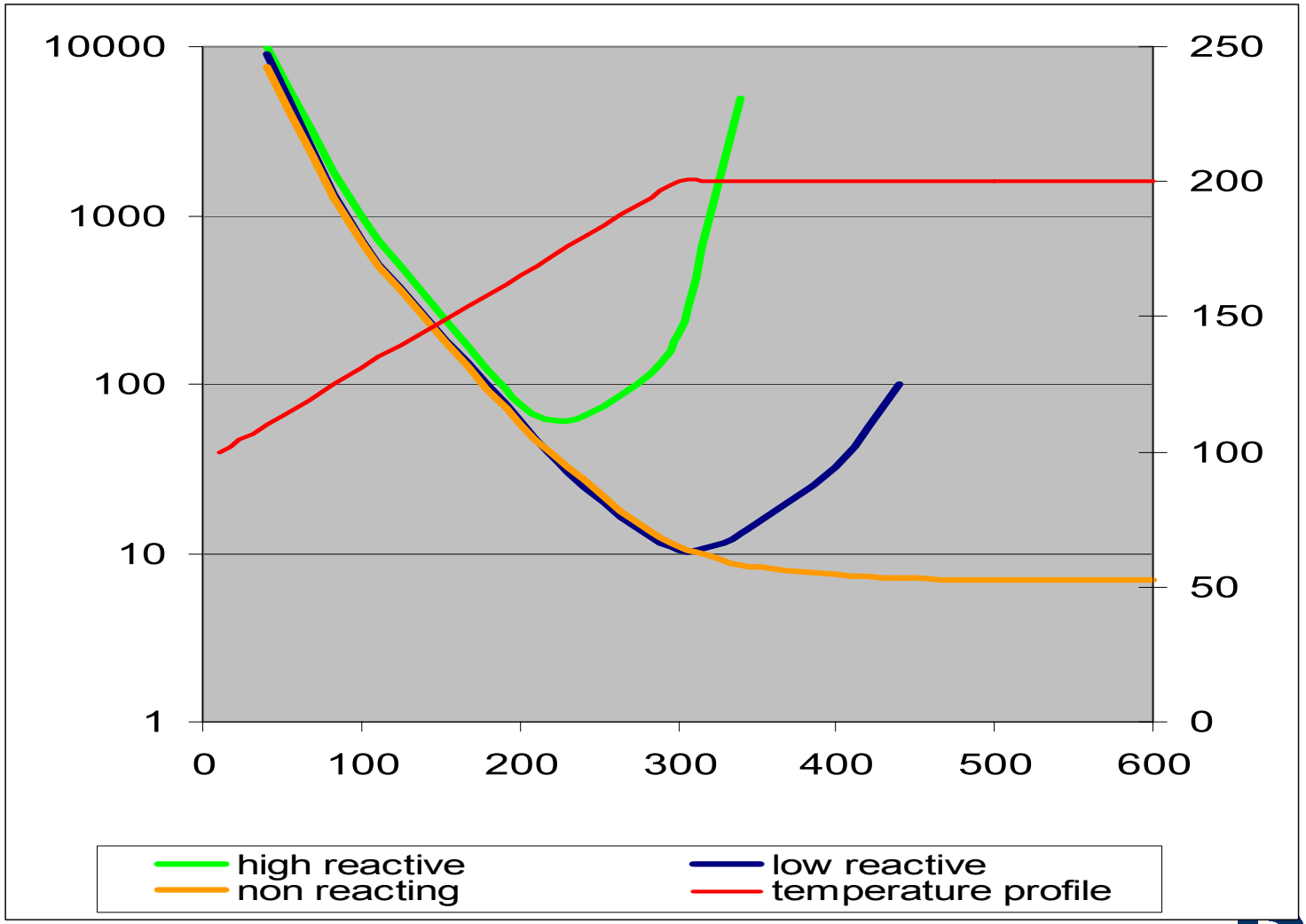
25°C
high viscosity

100°C
start melting
decrease viscosity
increase flowing

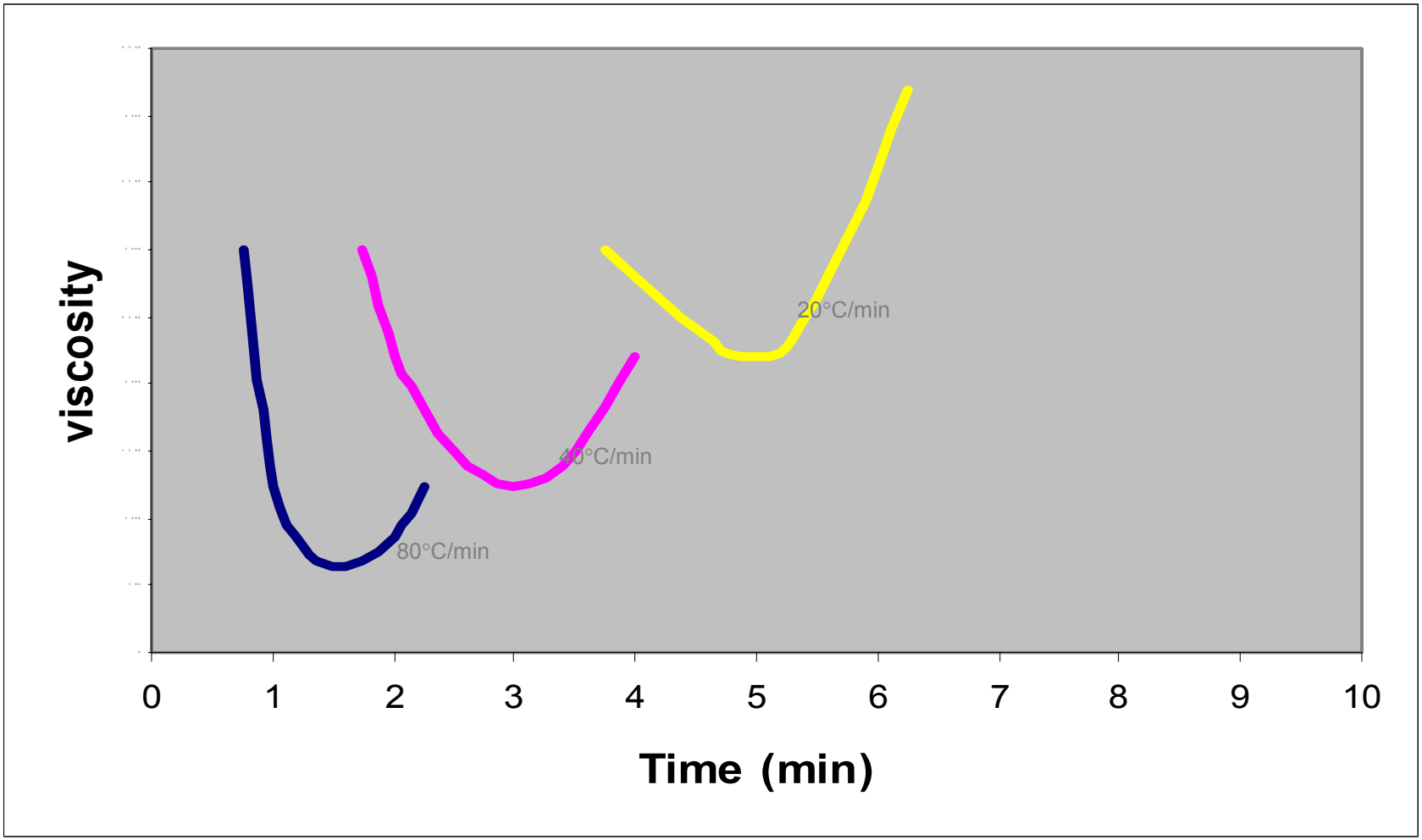
150°C
start reaction
increase viscosity
decrease flow

200°C
high viscosity
flow stops
x-linked film

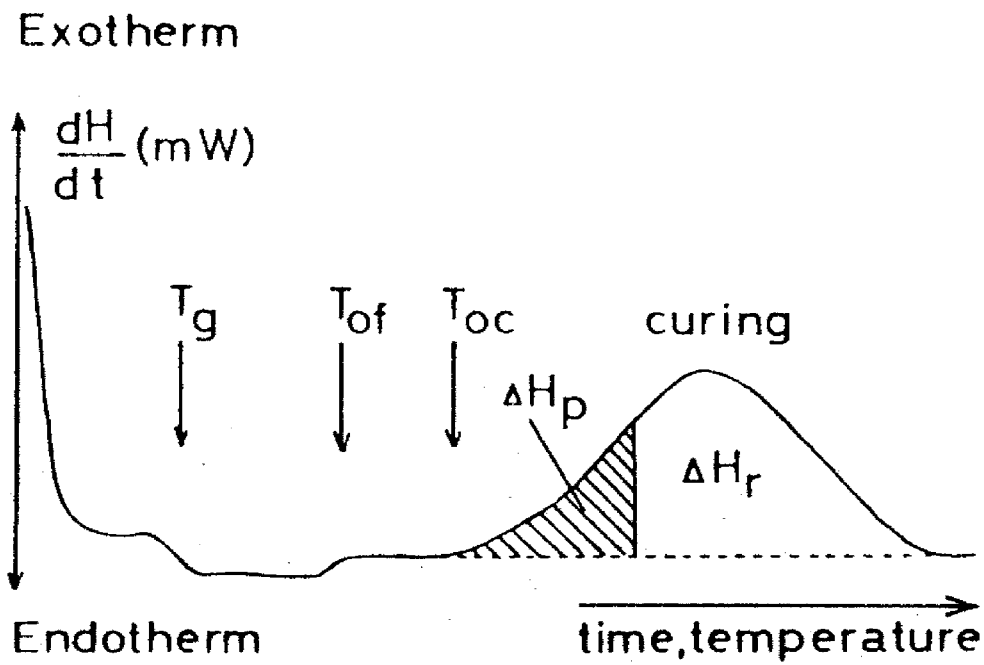
Viscosity curves



Influence of melting rate on viscosity



Simplified DSC curve



Geïdealiseerde DSC-curve van een polyester/epoxy poeder coating.

Influence of particle size

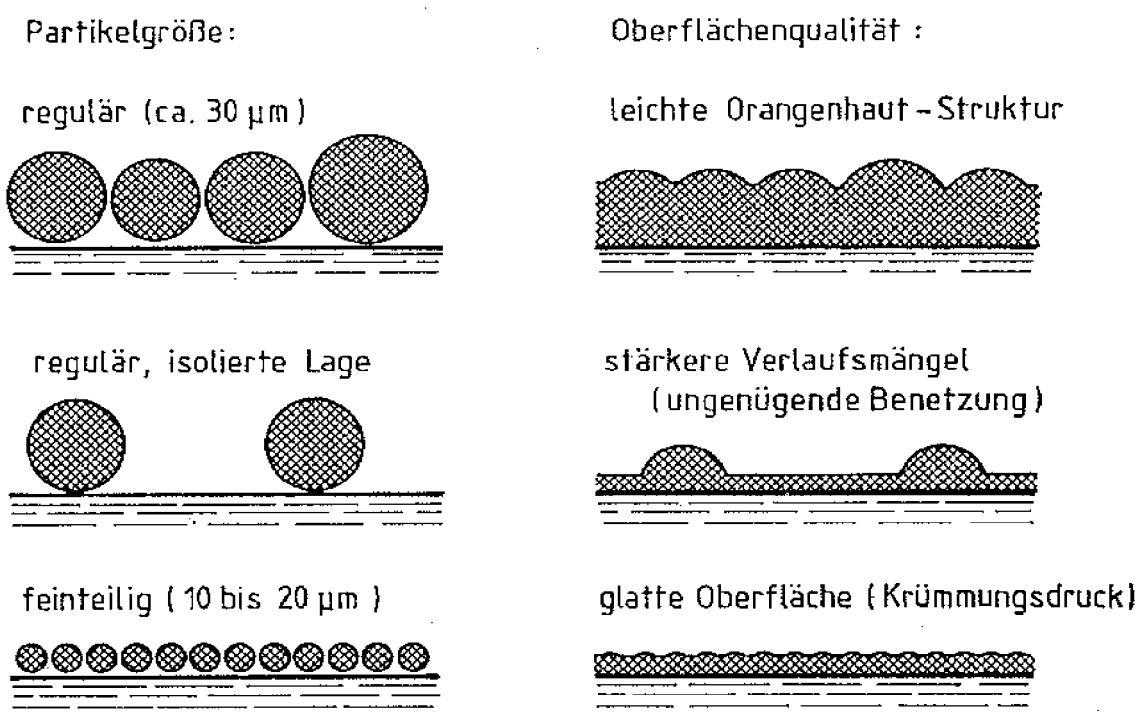
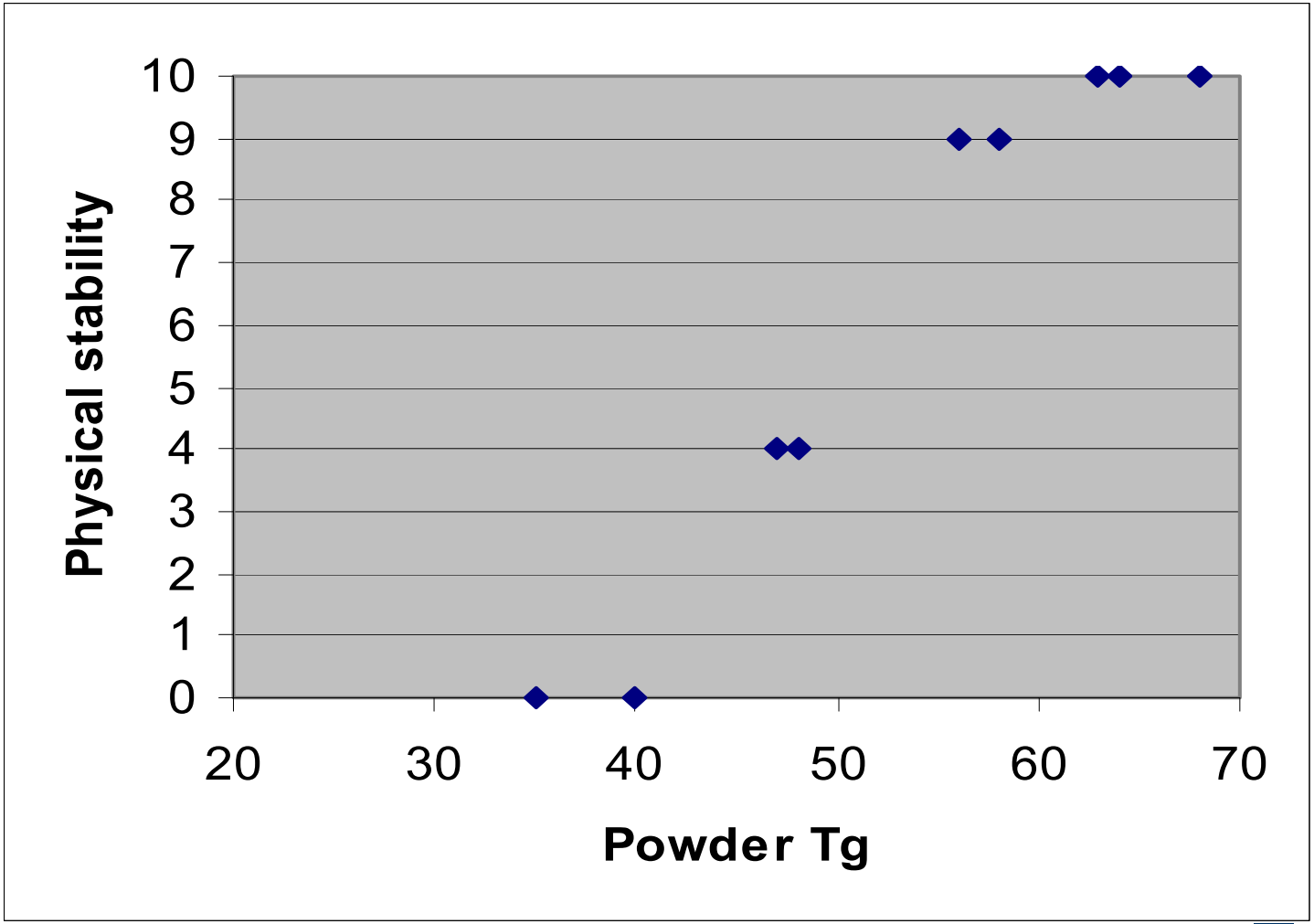


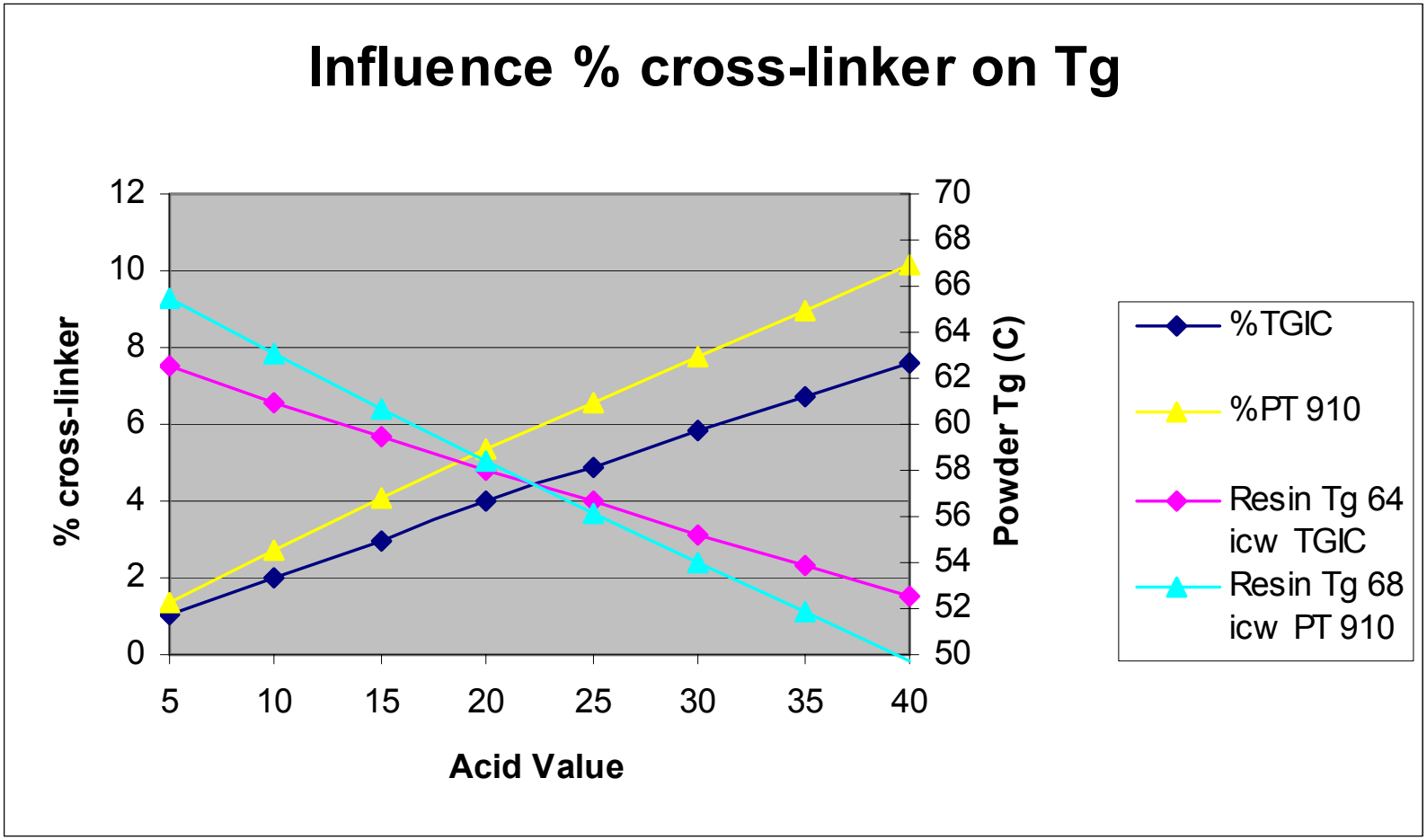
Abb. 3: Schematische Darstellung des Partikelgrößeneinflusses auf Verlaufsgüte und Konstanz der Filmschichtdicke

Tg versus physical stability

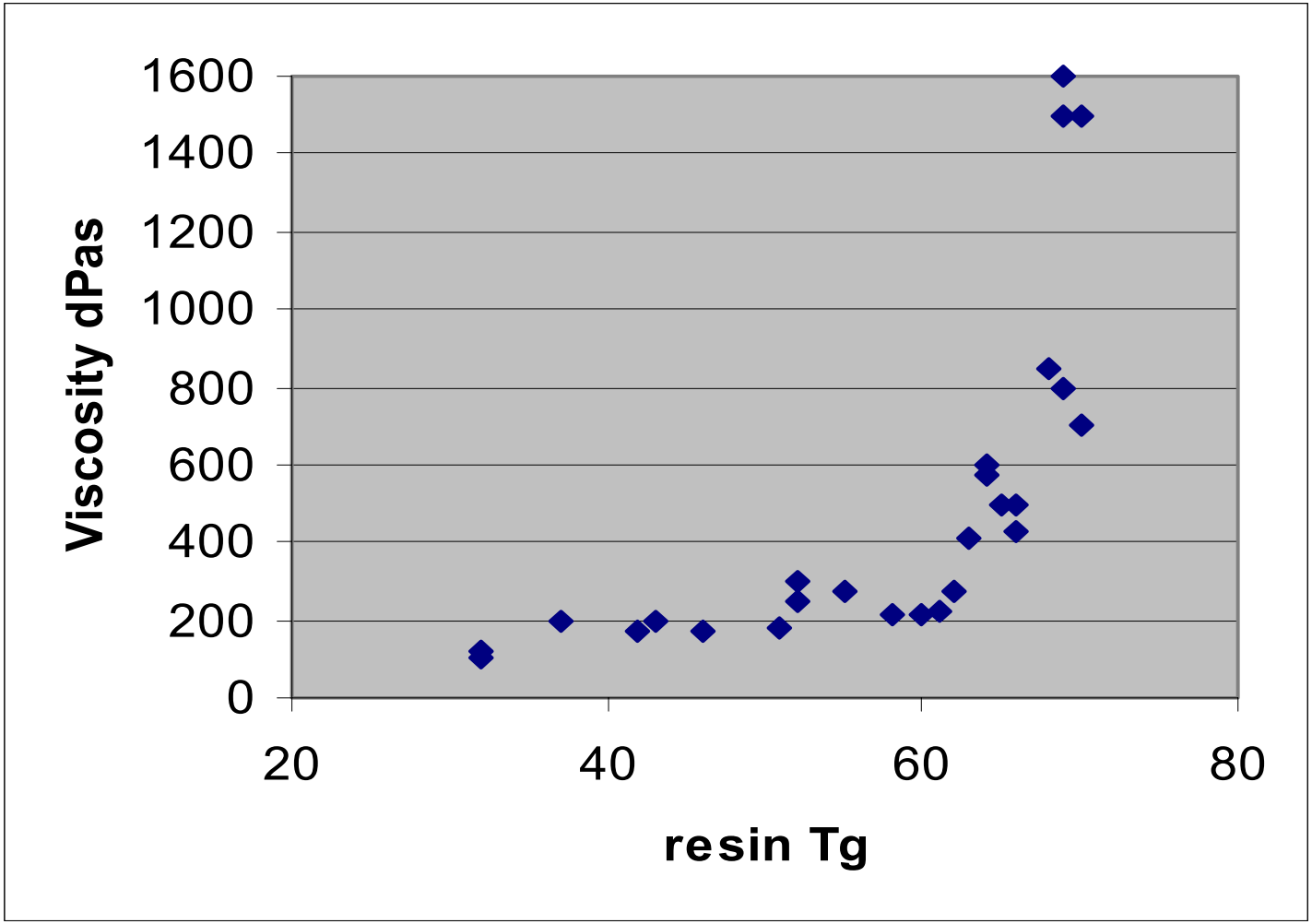


Influence % cross-linker on Tg

(only TGIC and PT 910, Primid XL 552 and Epoxy resin Powder Tg not (hardly) influenced)



Relation viscosity and resin Tg



Matting

- Powders are more difficult to matt than wet paints

- Techniques
- matting agents
- dry blend

Mat powder coatings (Dry blend systems)

- fast with slow,different AV or different chemistries
- In generally wheatherability and mechanical properties are OK
- Sparkling effect
- Extra processing step involved
  - TGIC

    E.g. P2220/P4800 with wax
    - Freedom of formulation
  - TGIC/PUR
    - Freedom of formulation

Mat powder coatings

- Primid

  E.g. P870/P833, P873/P835 (optional with DT3329)

  + gloss setting, mechanical properties
  - water split off can give disturbances, gloss variations per layer thickness, very low gloss is difficult

- PT910

  E.g. P2240/P3487 with wax (DT 3329)

  + no splitt off
  - moderate mechanicals, powder stability, not very low gloss

- PT910/Primid

  + low gloss possible
  - bad mechanicals