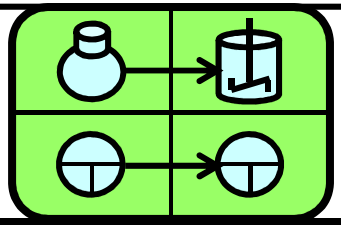
R&D Project Management in the Chemical Industry



The following collection of PowerPoint® Charts is intended to further clarify and supplement the relevant specialist publications on the subject matters dealt with. This collection in no way is used for any commercial purposes, but as learning material for students.

Selected sources for in-depth studies of the respective subject matters are given in some lists of references.

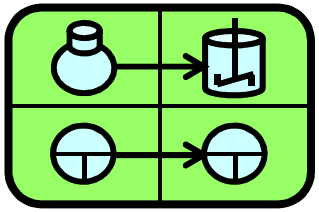
The chemical-technical target components, formulas, deadlines, data, project structures and action plans shown in project examples P1-P3 are widely with a practical orientation, but yet purely fictitious. They are solely used for a clear illustration of the particular topic and for learning purposes.

The names of all persons with project functions are solely fictional. Matches with the names of other people would be purely coincidental.

Rainer Buerstinghaus

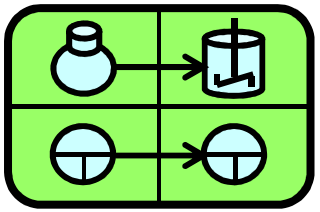
R&D Project Management
in the Chemical Industry

The Subject Matter



- **Innovations: Characteristics, Measures for its Promotion, Process Variants.**
- Three Examples for Innovation Projects (Chemistry and Technology):
  1. Highly Elastic Clear Coats for the OEM Automotive Sector.
  2. Nitrilase Catalyzed Synthesis of a Chiral Hydroxy-Carboxylic Acid.
  3. New Metal-Organic Frameworks for the Adsorptive Storage of Gases.
- Projects, Target Systems, Project Management in R&D.
- Appropriate Organization and Effective Structure Planning of R&D Projects.
- Project Flow Planning, Milestones, the Stage-Gate®-Process, Network Diagrams.
- Effective Implementation and Control of R&D Projects, Trend Analyses.
- Success Risks: Identification, Classification and Treatment.
- Recruitment and Lead of Project Staff:
  Chemists (m/f/d) – Team Players, Pacemakers and Executives in Projects.
- Project Manager (m/f/d): Tasks, Leadership Functions and Personality Profile.
- The Systematic Evaluation of Individual R&D Projects.
- R&D Strategy: The Planning of a Project Portfolio.

R&D Project Management in the Chemical Industry



Subject Matter →

Innovations:
Measures for its Promotion.

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Innovations: Measures for its Promotion

Product and Process Improvements are Permanent Tasks Within the Own Company!

"Progress is achieved not by satisfaction but by dissatisfaction with the existing situation!"

"The best way to foresee the future is to shape it!"

(According to Peter F. Drucker)

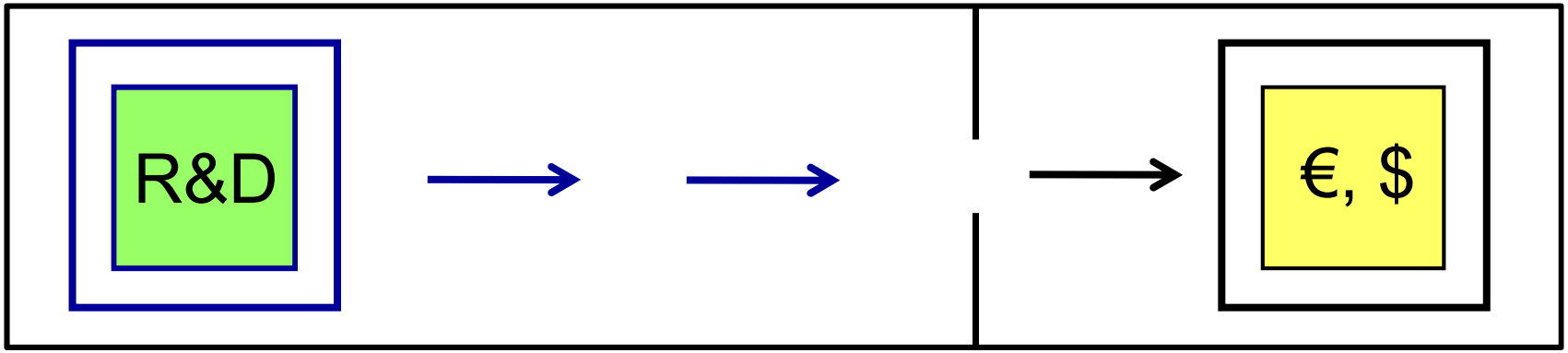
Innovations: Measures for its Promotion

Solid "Bases" for the Creation of Innovations.

- In-house research and development.
- R&D cooperations with universities and/or with research institutes.
- Awarding of R&D contracts to contract research institutes (Especially if there is no in-house R&D).
- Takeover of third parties: Acquisitions of companies (including the existing patent portfolio, the technology and the current market shares).
- "Purchasing", including a licensee contract.

Innovations: Measures for its Promotion

***Focused* Investments in Research and Development will Generate Long-Term Innovation Successes in Growth Markets, Resulting in Sustainably Effective Contributions to Earnings.**



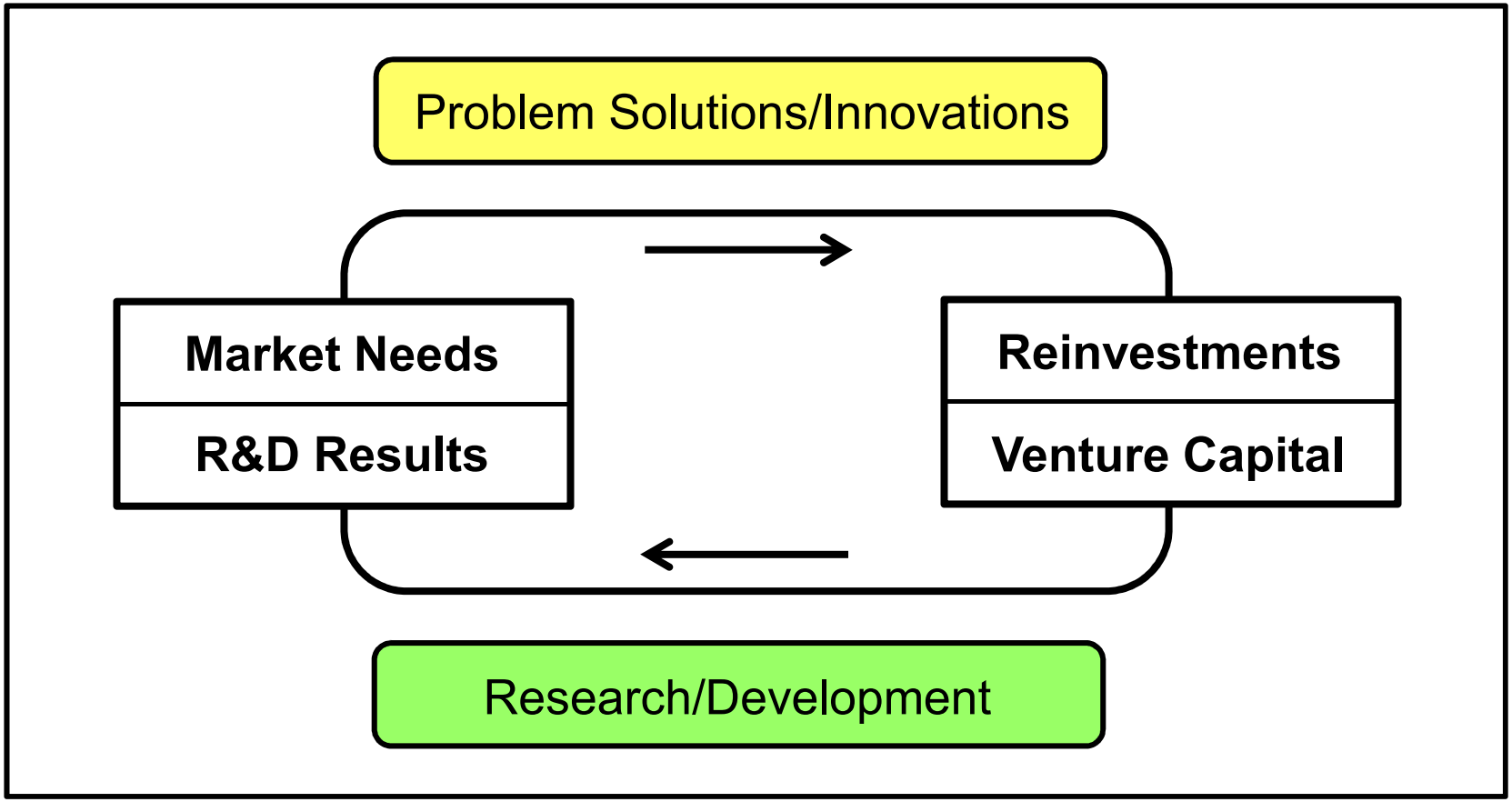
- Well-founded Research-Expertise.
- Motivated "Knowledge Carriers".
- Smooth Cooperations.
- Top Equipment/Top Instruments.
- "Critical Mass" in Research/Dev.

- High Returns.
- Top Technology.
- Best Functionality.
- Robustness.
- (Re)Producibility.

Innovations: Measures for its Promotion

Reinvestment of R&D Results: Cycle of Innovation.

Efficient "Drivers": R&D Projects!



Innovations: Measures for its Promotion

Goal-Oriented, Systematically and Sustainably Practised Research and Development Activities.

- Reasonable innovation strategy in relation to ones own technologies, products, processes and ones own feasible opportunities in the market.
- Long-term, goal-oriented and professionally executed research and development work.
- Effective "Research Radar" and "Technology Scouting" at the world`s leading universities and at excellent research centers.

Innovations: Measures for its Promotion

Goal-Oriented, Systematically and Sustainably Practised Research and Development Activities.

- Targeted allocation of externally carried out contract research activities to first-class competence centers and technical institutes.
- Cooperations with excellent university-research groups / other top research groups (e. g. at MPIs).
- Strategic research alliances with pilot customers, having proved competence in the target market (Ideally: Market- and technology leadership).

Innovations: Measures for its Promotion

Promotion of Chemical-Technical Inventions:

- Continuous reviewing and analysis of the latest state of science (Specialist Publications).
- Regular retrieval and evaluation of the latest state of the art (Patent Literature).
- Systematic reviews of both, the own and the external research results on their applicability for commercially usable problem solving.
- Performance of periodic "inventor conferences" within the own company.

Innovations: Measures for its Promotion

Systematic Exploration of "Sources of Ideas":

- External/internal literature, primary publications.
- New raw materials/reagents/chemicals.
- Unexpected results from (laboratory) experiments.
- Particular I.T.- and/or A. I.- applications,
  e.g. molecular modeling or bioinformatics.
- Creative workshops (brainstorming, brainwriting).
- Transdisziplinary problem-solving processes
  (e.g. "morphological tableaus").

Innovations: Measures for its Promotion

Systematic Exploration of "Sources of Ideas":

- Market Analyses/Discussions with customers.
- Activities of individual competitors.
- Complaint Reports on Products or on Services.
- Communications Networks, facebook®, twitter®, etc.
- Inspiration (Culture, Science, Technique, etc.).
- Colleagues/Employees/Supervisors.
- Analogous considerations with innovation results from companies outside of one`s own industry.
- "Zeitgeist"; Generally defined needs.

The Systematic Screening and Evaluation of "Windows of Chances" in the Chemical Industry:

Internal Signals

- Unexpected reaction courses.
- Unpredictable catalytic effects.
- Failed experiments (temperature-, time control, reactants: Quantity ratios, purity of products).
- Incongruences, unwanted formation of by-products.
- Chemical-technological "weak points": Sustancial need for process improvements.

Innovations: Measures for its Promotion

The Systematic Screening and Evaluation of "Windows of Chances" in the Chemical Industry:

External Signals

- Changes in the population structure: demographic changes, effects of migration.
- "Landslides" in the markets, transformations in industries that are interlinked.
- Paradigm shift, other general perceptual patterns for chemistry (products) or genetic engineering (products).
- Legislation: Environmental policy plans.
- Research results from other specialist disciplines.

Innovations: Measures for its Promotion

Creation of an "Innovation Culture" Within the Company:

- Staff with a high willingness to cooperate.
- Numerous "problem solvers" with intrinsic motivation.
- Accordance between personal and achievable innovation objectives.
- No internally competing activities or in-house redundancies.
- Lean, flexible und unbureaucratic steering processes ("operational agility").
- Professional data storage, appropriate information- and documentation management.

Innovations: Measures for its Promotion

The Generation of Openness to Something New:

- The own company allows freedom for unscheduled experiments and for the emergence of new knowledge ("emergence clusters").
- New ideas and project proposals are perceived as opportunities and not as "risks" or as "burdens".
- The "hidden game variants" (unwritten laws in the company) and the real / aspired corporate culture fit together.

Promotion of Incentives for a Free "Flowing" Creativity.

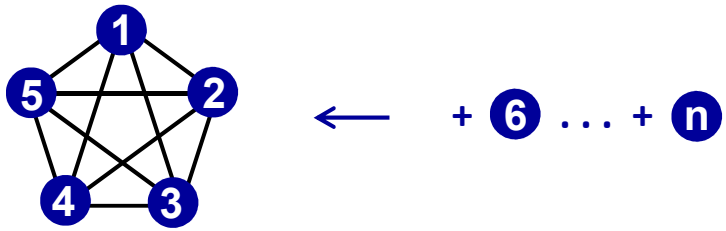
Creativity as an effective mental strength:

- "The *Real Voyage of Discovery* consists not in seeing new landscapes but in having new eyes" (Marcel Proust).
- Creativity is the ability to combine information unlike the usual way.
- Prerequisite for a free flowing creativity:
  Open, divergent thinking ("360 degree radar").

Innovations: Measures for its Promotion

Stimulants for a Steadily "Flowing" Creativity:

1	Regular exchange of ideas with (natural) scientists (m/f/d) and technicians (m/f/d) from *other* disciplines.
2	Avoidance of rigid thought patterns basing on one's own knowledge for upcoming solutions to complex problems.
3	Actively bringing about one´s own paradigm shift by self experiencing different “customer worlds”, directly on site.
4	Careful analysis of the development processes for key innovations from other industries.
5	Regular visits to concerts, theater performances, museum exhibitions and other cultural events.
+…n	↓ ↓ ↓



$(K_5)\ \begin{bmatrix} 5 \\ 2 \end{bmatrix}$

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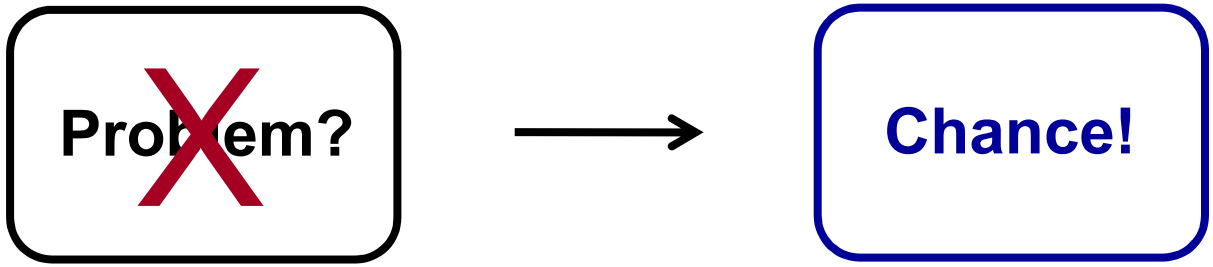
Innovations: Measures for its Promotion

Basic Renunciation of "Killer Phrases"!

Killer phrases are "poison" for the creation of real innovations!

Paradigm: "Optimism is a moral duty!"
(Sources: Immanuel Kant and Karl Popper)



Innovations: Measures for its Promotion

Largely Renunciation of "Killer Phrases" (X) !

X	"We have never done it in this way!"
X	"That will never pay off ..."
X	"We have already thought of that before now!"
X	"Many made vain attempts for it ..."
X	"The company XY has previously come with such plans into a financial imbalance!"
X	"That may be theoretically correct, but ..."
X	"At first, you have to draw up the details for that ..."
X	"For this, we today lack the resources!"
X	“My boss will certainly never allow that!"
X	"Did you already take into account, that ..."

Innovations: Measures for its Promotion

Largely Renunciation of "Killer Phrases" (X) !

X	"If it were that simple, the competitors would have done that a long time ago!"
X	"This is a great idea, but ..."
X	"This is not possible with our organization!"
X	"We currently have no time for that!"
X	"Not any customer will be interested in that!"
X	"There's a lot of bureaucracy within it!"
X	"Our daily business has absolute priority!"
X	"Until we have finished, the market has changed!"
X	"First of all, we have to wait for the opinions from the other managers (m/f/d) of specialist departments!"

Innovations: Measures for its Promotion

Implementation of a Structured Innovation Process.

- **Convincing Company Strategy** →

  Close coupling of the innovation targets to the business strategy. Clear strategy for products, services and for the system. Careful selection of the most suitable development partners.

- **Professional Ideas Management** →

  Systematic idea finding and idea assessment in one's own company (cf. Stage-Gate® process).

- **Effective Project Management** →

  Professional planning, concrete actions, controlling.

Innovations: Measures for ist Promotion

Goal-Oriented, Systematically and Sustainably Practised Research and Development Activities.

Introduction and realization of a professional R&D project management in one's own company.

Research and Development Results	→ **Innovations**
Transformation of Basic Research Results	→ **Innovations**

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Innovations: Measures for its Promotion

Professionally Executed R&D Project Management.

- **Preliminary Phase**

  Complete planning with clear objectives and prior clarification of the chemical, technical and legal conditions; Examination of the patent situation; If necessary, cooperation contract agreements and (or) licensing contracts.

- **Project Implementation**

  Strictly action-oriented realization of the current planning specifications by means of unambiguously defined deadlines and suitable, clearly designated persons in charge.

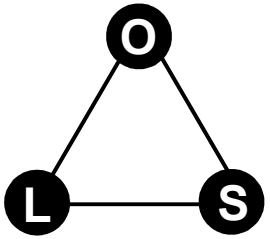
- **Project Completion**

  Final prototype development in cooperation with a pilot customer; Intensive penetration into the target markets; Documented conclusion ("Lessons learned").

Innovations: Measures for its Promotion

Strategic Influence Factors in the Chemical Industry.

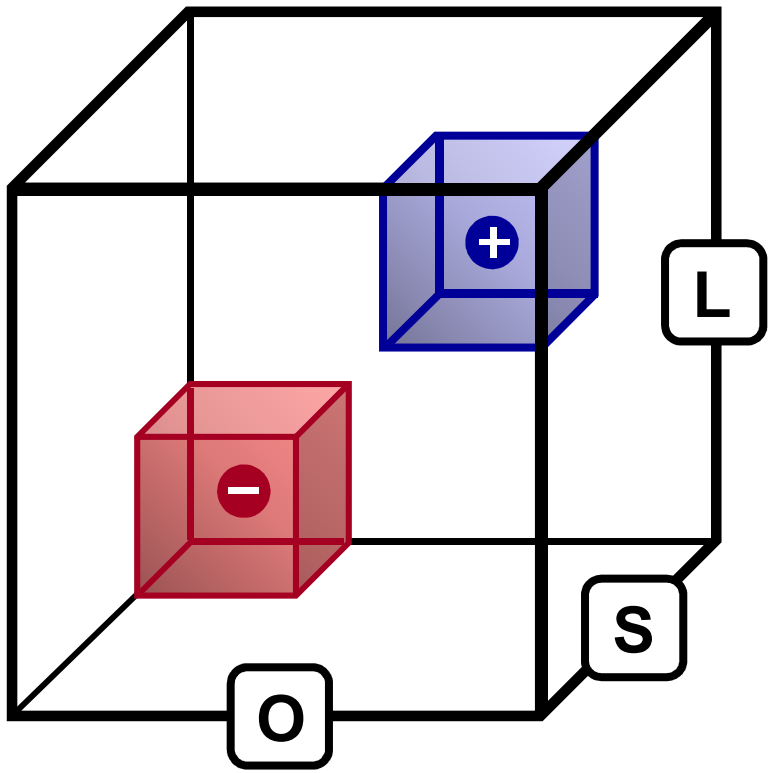
Triad	(O, L, S)
O	Organization of Research and Development
L	Lab Equipment (Devices, Technology, Chemicals)
S	Qualified Staff (Non-Tariff / Tariff Employees)



(K_3): $\begin{bmatrix} 3 \\ 2 \end{bmatrix}$

Innovations: Measures for its Promotion

Strategically Effective Influencing Factors, → "Innovation Space"



Organization (O)

- Division of Work.
- **Collaboration.**

Lab/Technology (L)

- Realization of Standard Tasks.
- **Realization of Pioneer Tasks.**

Staff (S)

- Extern. Controlled.
- **Self Determined.**

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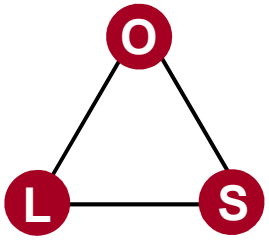
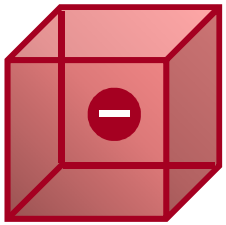
Innovations: Measures for its Promotion

Negative Factors, Hindrance to their Development:





??

(O): Individual Works	→	Coordination Effort
(L): Standard Methods	→	Standard Solutions
(S): Orders/Controls	→	Reaction/Resignation

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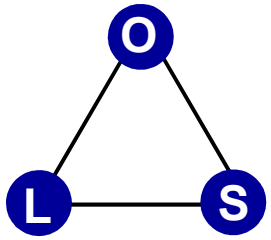
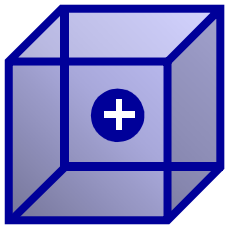
Innovations: Measures for its Promotion

Positive Factors, Support of their Emergence:





Results of Effective Project Work!

(O): Cooperation

(L): Top-Methods

(S): Competence Gain

→ High R&D Productivity

→ Pioneer Solutions

→ Intrinsic Motivation

Innovations: Measures for its Promotion

Organizational Measures (O):

- Lean organization, low manager-to-staff ratios.
- Flexible information and action networks in R&D.
- Transdisciplinary work teams.
- Regularly occuring roundtables, expert forums.
- Wordwide idea contests for customer solutions.
- Global information policy, R&D debates.
- Continuous development of the R&D organization.

Innovations: Measures for its Promotion

(Laboratory) Technical Measures (L):

- For the achievement of objectives: Necessary and appropriate laboratory equipment.
- Systematic device maintenance/standardization/ calibration.
- Devices/Apparatuses on the state of science.
- Devices/Apparatuses on the state of technique.
- Professional planning of IT, as well as measurement and control technology.
- Competent technical purchasing/engineering technology.
- Installation of a safety technology with reference level.

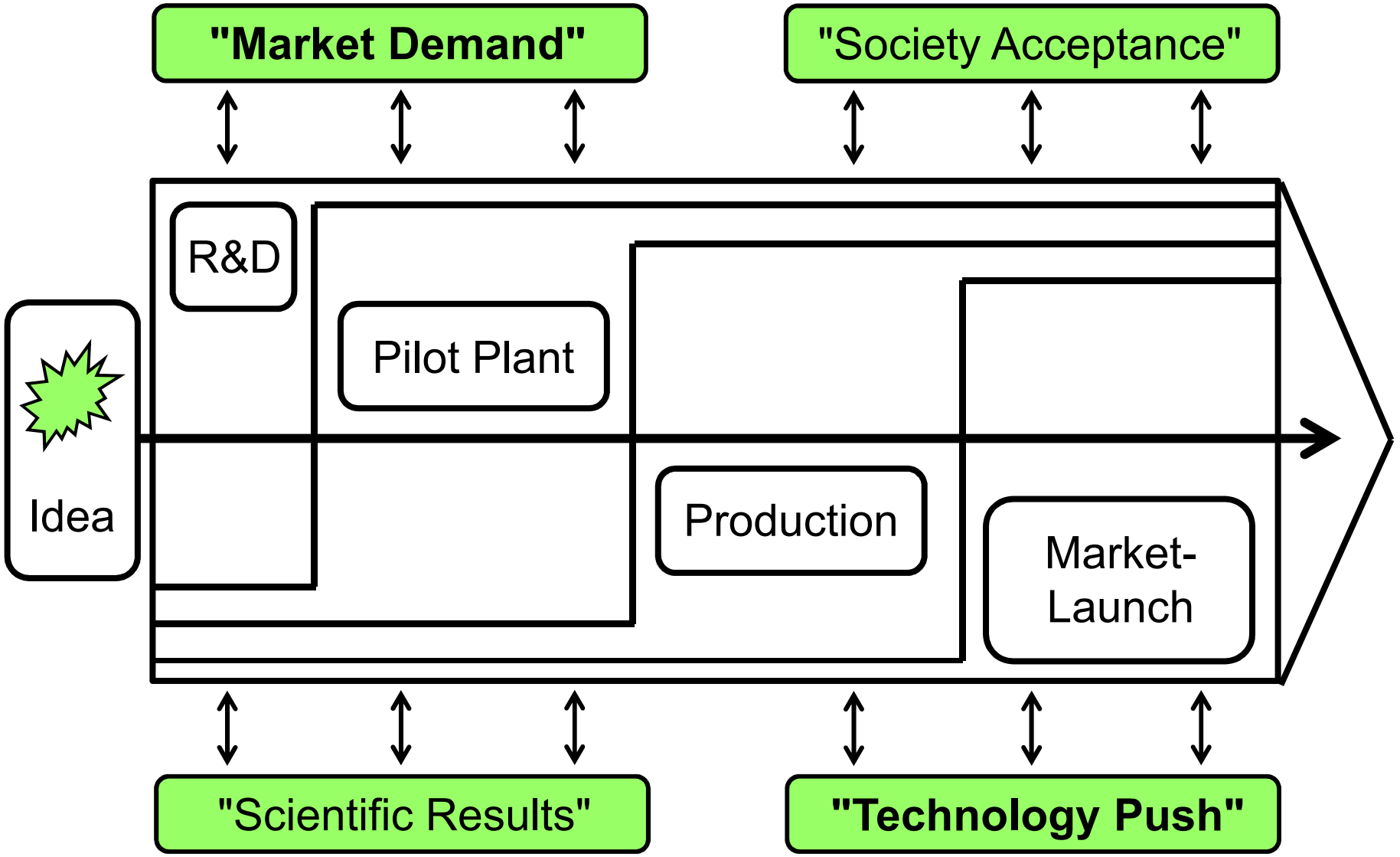
Innovations: Measures for its Promotion

Staffing Measures (S):

- Assessment and consideration of the personal innovation behavior (Remuneration!).
- Active involvement of the employees in information-/ planning-/decision making-processes.
- Transfer of individual results responsibility.
- Guarantee of a generally internalized understanding of teamwork.
- Personnel promotion, trainee programs, CIP, ESS.
- Realisization of time autonomy, "Time Accounts".
- Sometimes, the recruitment of "unconventional" employees.

Innovations: Measures for its Promotion

Systematic Check of External Innovation Drivers.



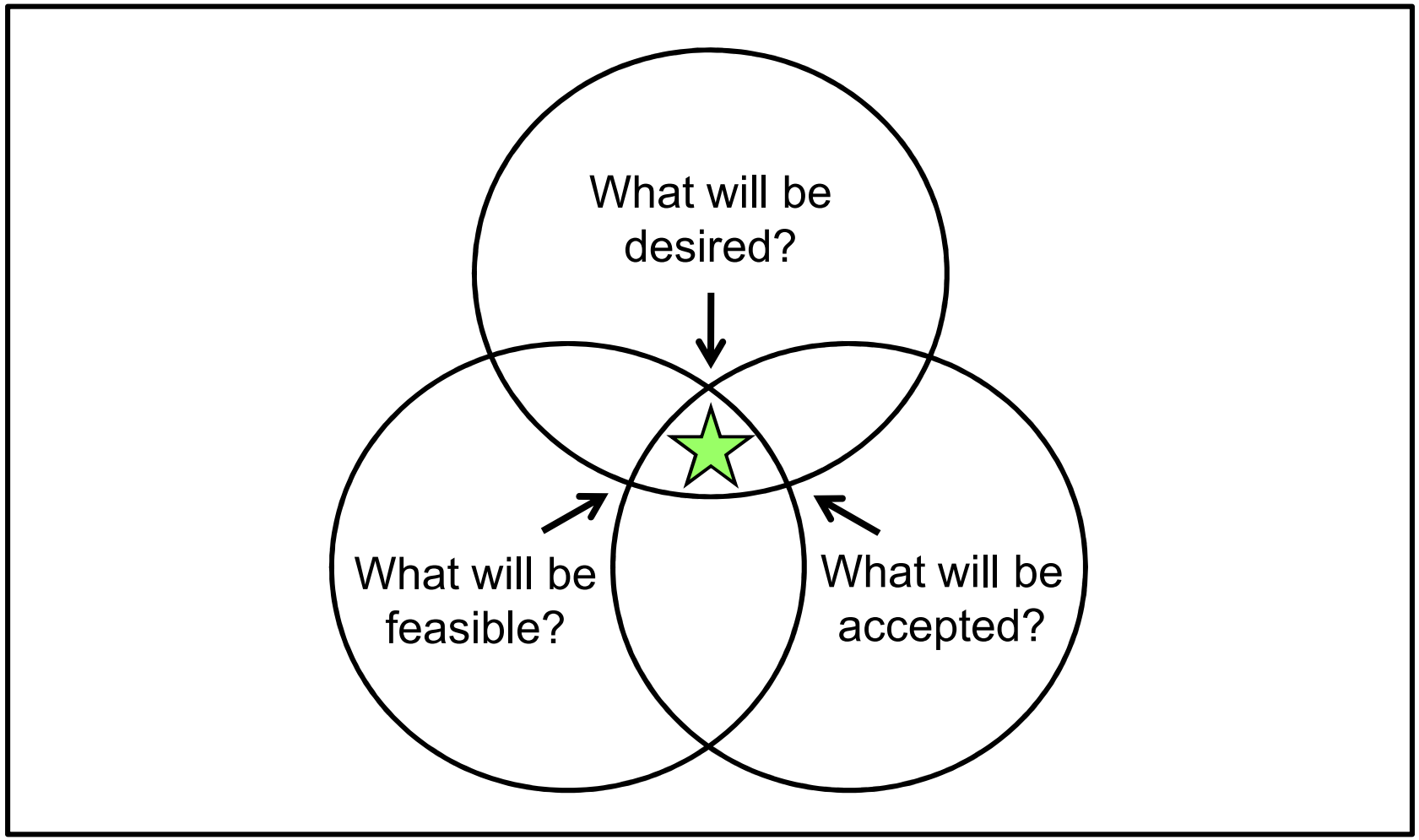
Innovations: Measures for its Promotion

Three Questions: Early and Clear Answers to *all* of these Questions are Effective Drivers of Innovation!

Market	→	**What will be desired?**
Chemistry/Technique	→	**What will be feasible?**
Society	→	**What will be accepted?**

Innovations: Measures for its Promotion

Three Questions: Early and Clear Answers to *all* of these Questions are Effective Drivers of Innovation!

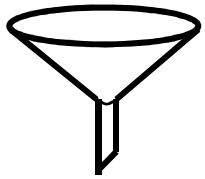


Innovations: Measures for its Promotion

Innovation process with increasing focusing:

≈ 175	**Ideas**
	↓
≈ 035	**R&D Projects**
	↓
≈ 015	**Products**
	↓
≈ 003	**Market Launches**
	↓
≈ 001	**Market Success**

Idea / Market Launch
≈ (175 / 001)



"Funnel for Selectivity"

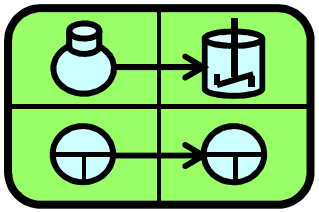
Estimates from the chemical and pharmaceutical industries (including small and medium-sized companies).

Innovations: Measures for its Promotion

The "Avoidance of Errors" in the Innovation Process.

"Innovation Management - The Ten Most Common Mistakes“. Lecture given by Jürgen Hauschildt at the Institute for Business Management, University of Münster, July 2004.	
01	Innovation is not seen as a solution to a market problem.
02	The degree of innovation is insufficiently determined.
03	The striven innovation is not defined holistically.
04	The own innovation capacity is overestimated.
05	The goals are set too rigidly, technical goals dominate.
06	Within the innovation process, creativity is unfolded in an uncontrolled manner.
07	The resistance against the innovation is underestimated.
08	There are no promoters for the innovation, it finds no encouragement.
09	Cooperation with market partners is either lacking or imperfect.
10	The innovation processes are controlled with instruments of routine action.

R&D Project Management in the Chemical Industry

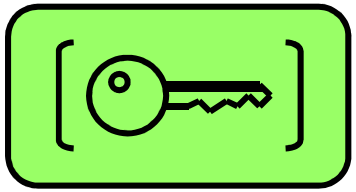


Subject Matter →

Innovations: Process Variants.

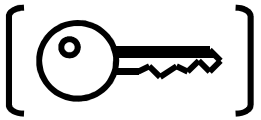
Innovations, Process Variants	(C: Company)

C 1 (Producer) ⟷ **C 2 (Customer/Partner)**

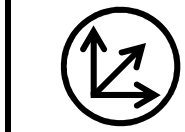


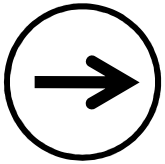
- Standard development.
- Technology leap.
- Technology partnership.
- Imitation-concept (2nd Follower-Principle).
- Modular system.
- Taylor-made solutions.
- Exclusive partnership (Joint Venture).
- Start-up-partnership.
- New applications in the market.
- Innovation-steered forward integration.
- Strategic research cooperation.

Innovations, Process Variants

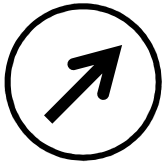


Different "Degrees of Innovation"

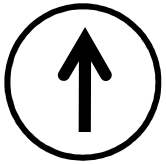




low



medium



high

Different "Leverage Effects" in Today's Market.

Different "Driving Forces" for New Markets.

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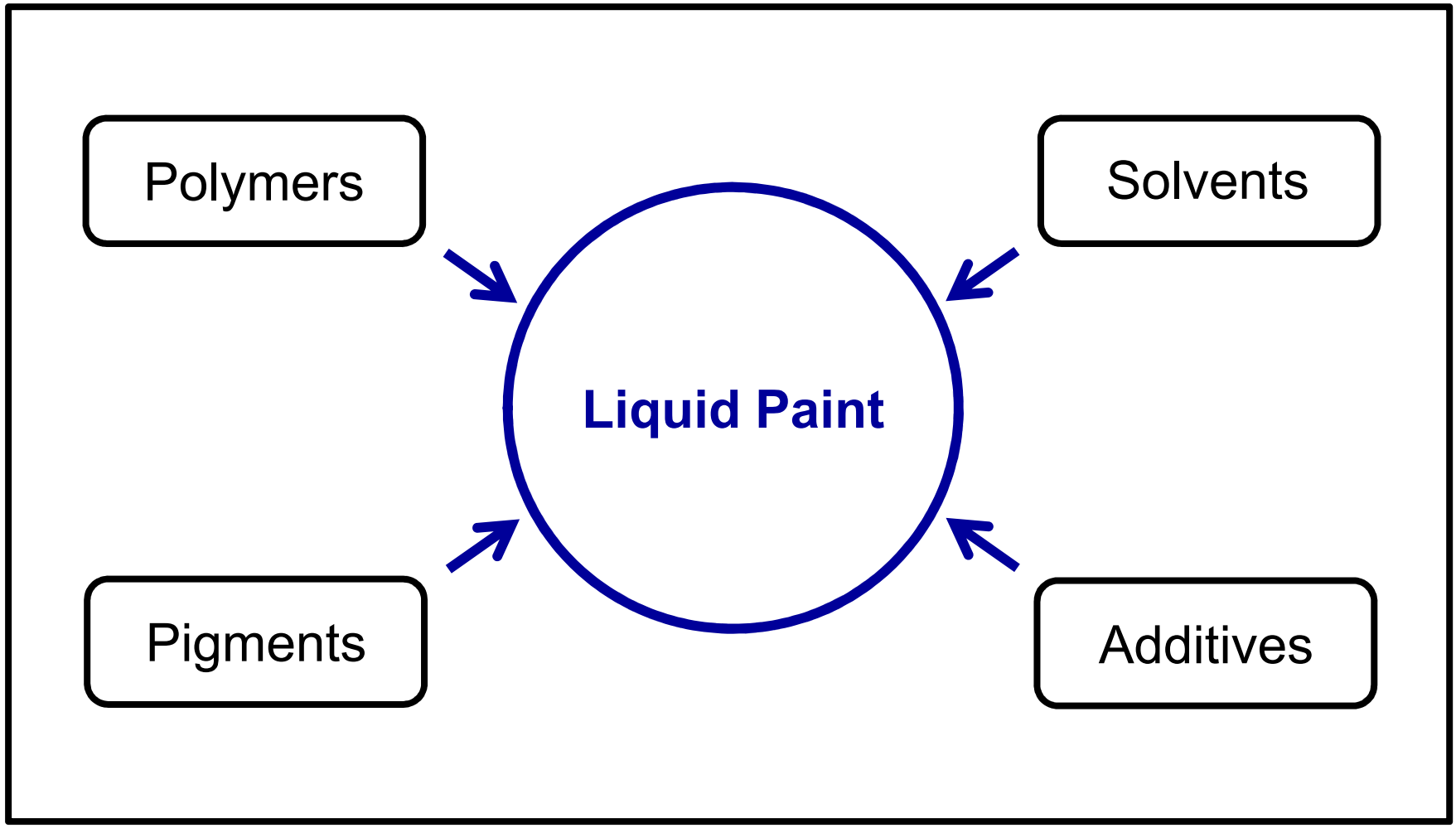
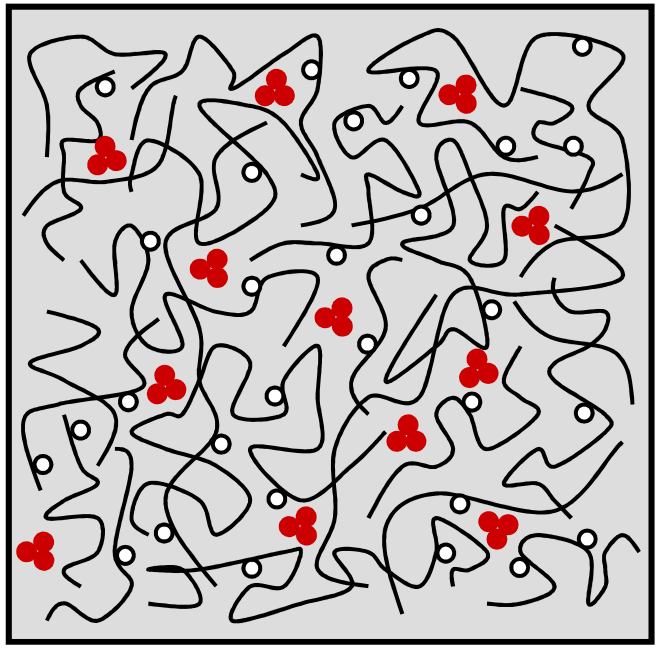
Lacquer as a Mixture of Four Basic Raw Material Classes.



Clear Coat: From Dissolved Coating Resin to Duromer.

Standard Clear Coat: Liquid film ⟶ Cured Film (T↑; Catalyst)

Coating Resin:
+ Crosslinker:

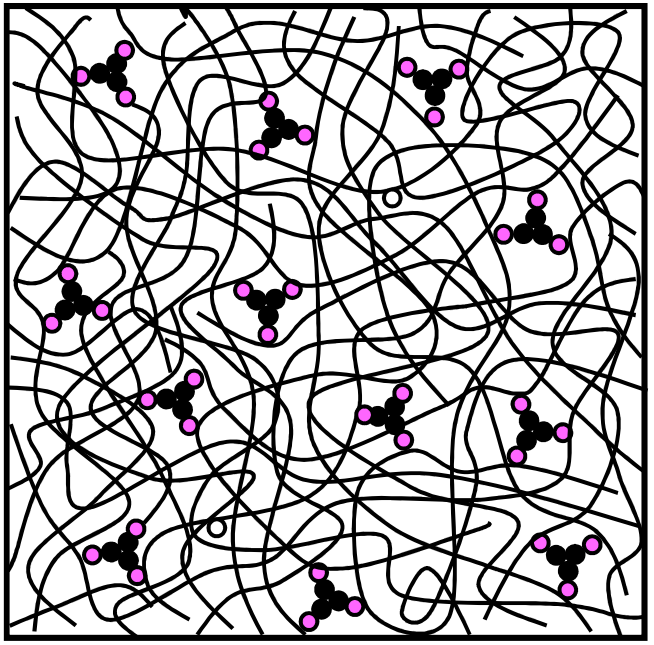


MW: $n_x - n_y$

(Soluble □ , Liquid)

≈ 120°C

Coating:
Duromer, Glassy



MW: $m_k - m_l$, $m \gg n$

(Insoluble, "Solidified")

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Innovations, Process Variants

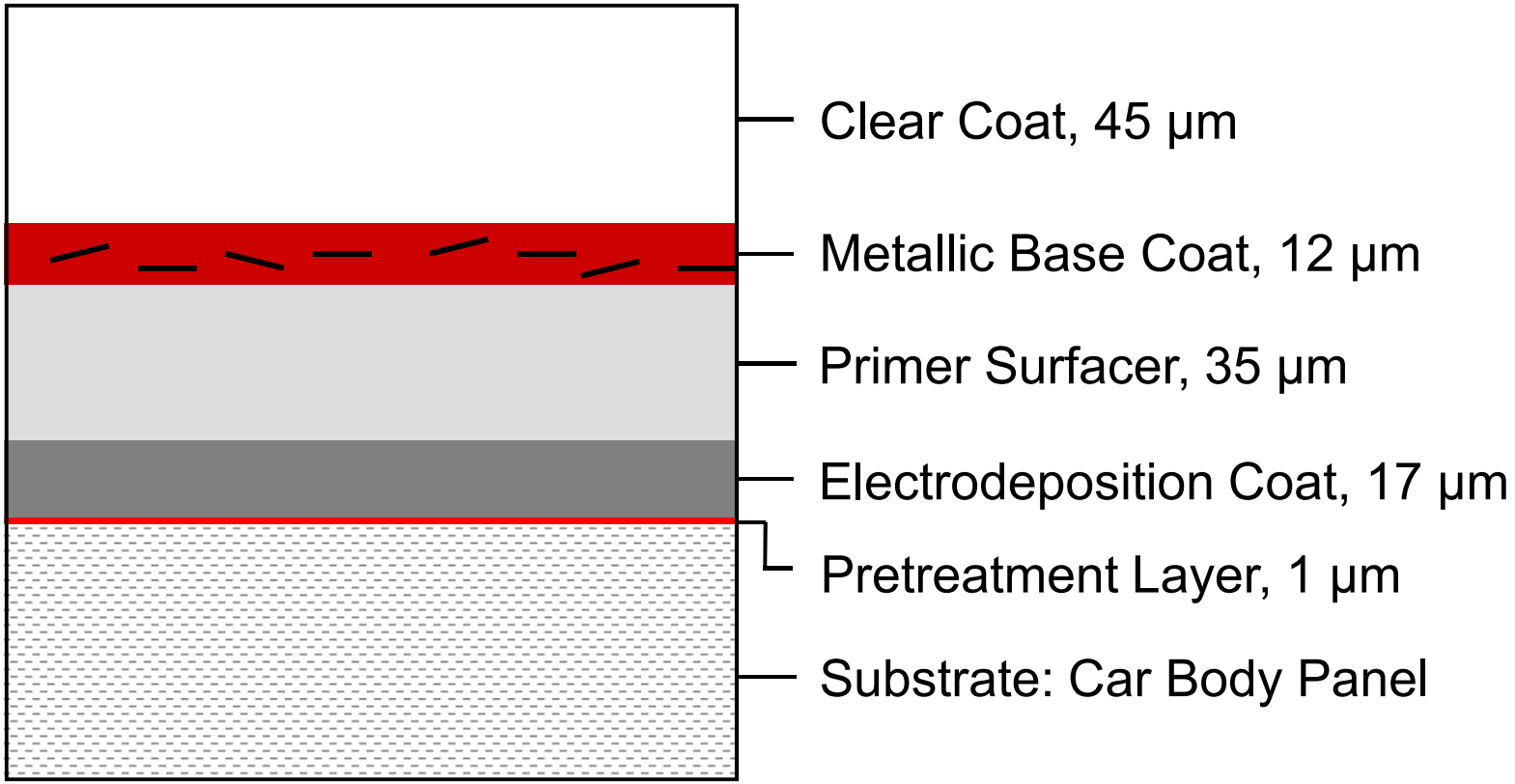
Coatings: Process Variants for Film Curing.

Liquid Lacquers, Possibilities for Crosslinking of the Films.

Thermal radiation	Metal-Ions
UV-Light	(Organo)-Catalysis
X-Rays	Acids/Bases
Electron beams	Air: O_2-Diradical

Four-Layer Automotive Coating (OEM), 2021

Typical System, Standard Technology for Series Production.



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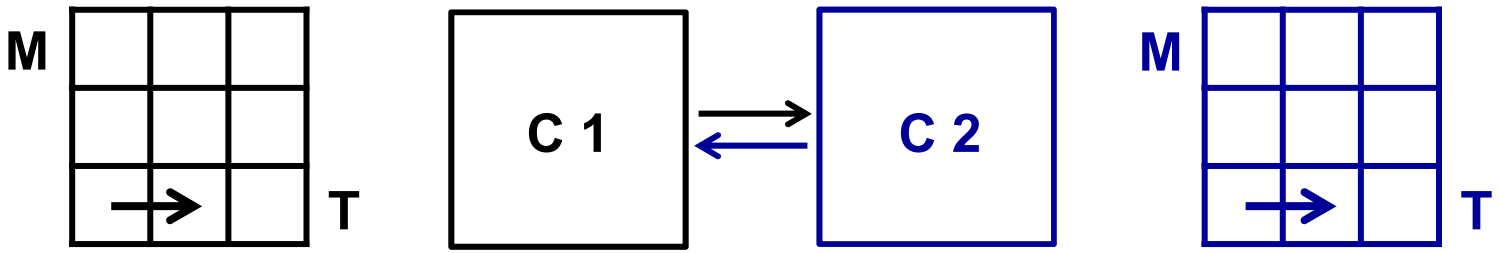
Innovations: Prerequisites for Market Success With the Process Variant Explained Here and its Characterization.

- Technical competence.
- "Correct" chemical and technical translation of the current routine require-ments from the production and the market.

→

Standard Development

Own R&D work to improve existing products and processes.



M: Market Attractiveness

T: Technology Position

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Innovations, Process Variants.

Example

- Technical competence.
- "Correct" chemical and technical translation of the current routine require-ments from the production and the market.

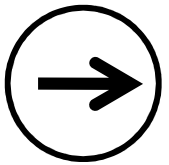
→

Standard Development

Own R&D work to improve existing products and processes.

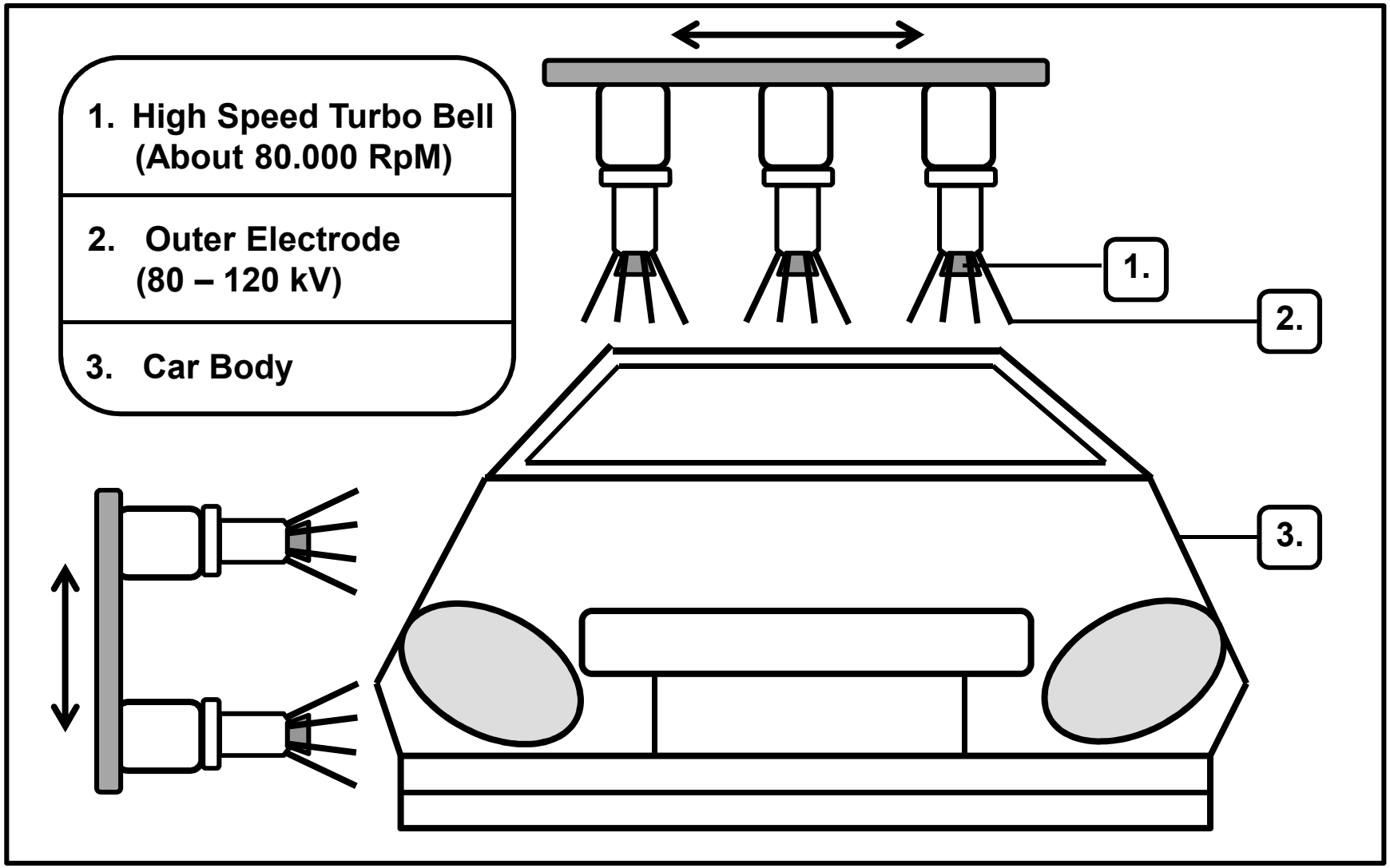
Continuous improvement of the stone chip resis-tance of polyurethane filler layerss on electrodepo-sition coated car bodies (OEM).

Systematic variations of the diisocyanates, polyols and filler materials according to the feedback of the technical customer service.



Paint Application During Automotive Production.

Electrostatic Application of a Liquid Filler (Scheme):



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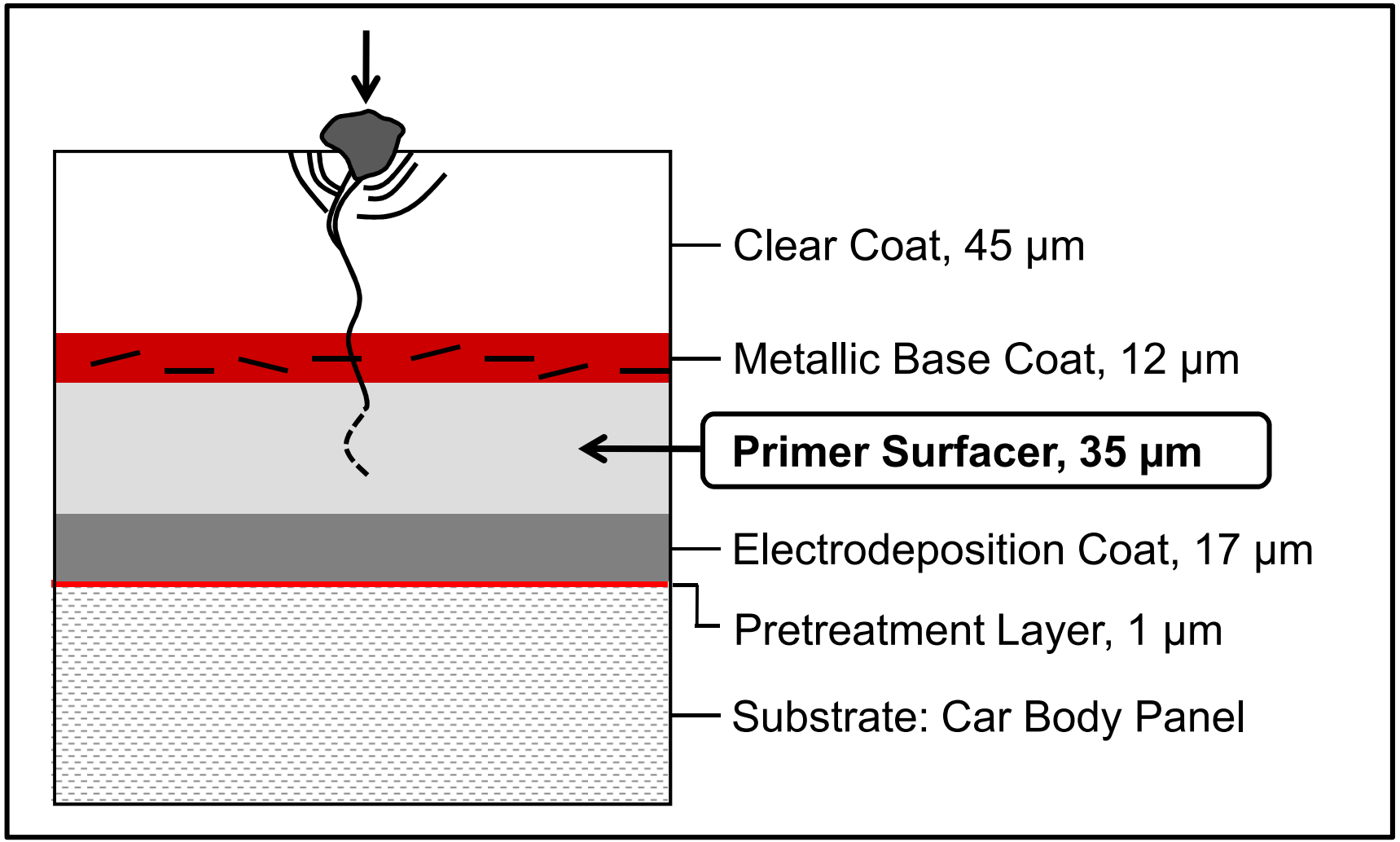
Four-Layer Automotive Coating (OEM), 2021.

Primer Surfacer: Stone Chip Protection for the Car Body Sheet:



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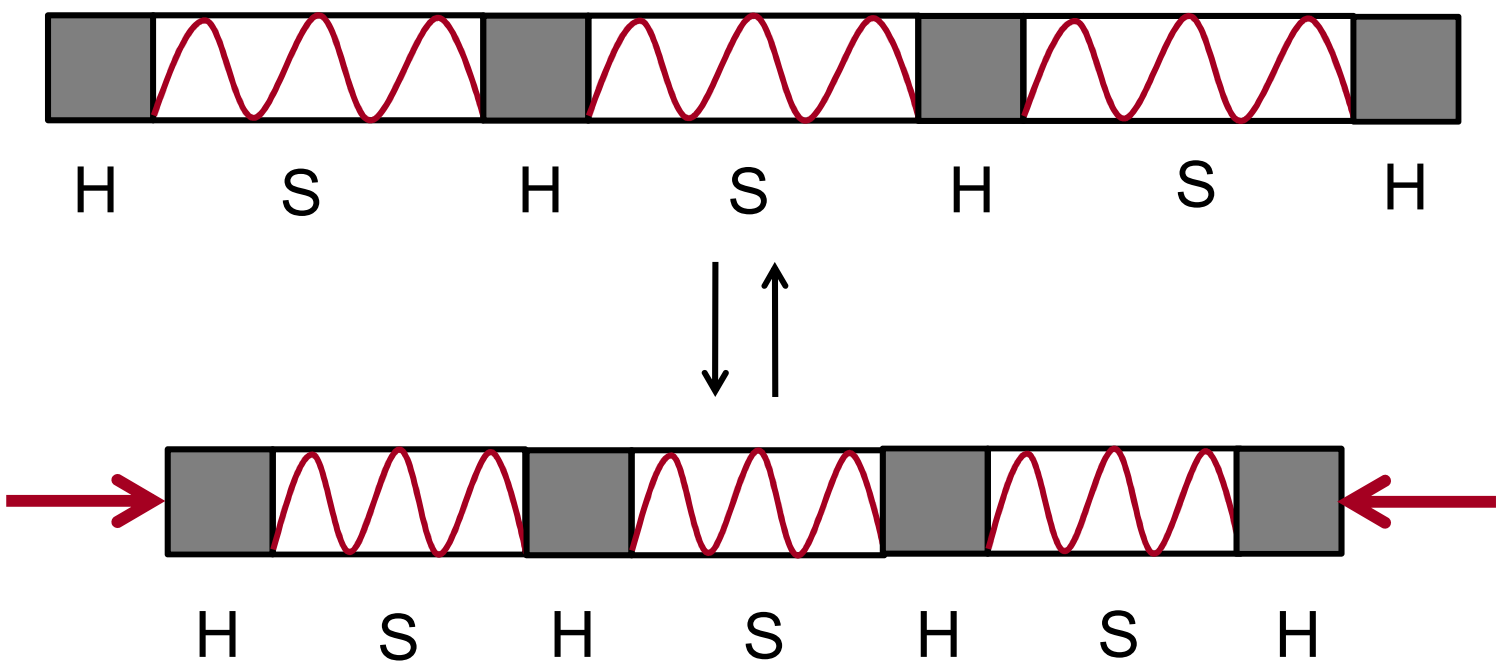
Waterborne Automotive Primer Surfacer (OEM).

Basic Structure of a Polyurethane Framework, High Elasticity.



H: "Hard Segments" (Diisocyanates); "Compact" Building Blocks

S: "Soft Segments" (Diols) "Flexible" Building Blocks

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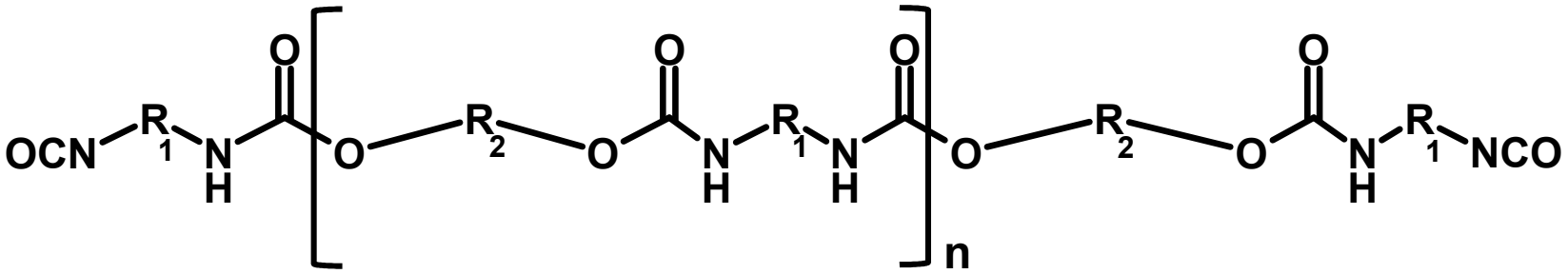
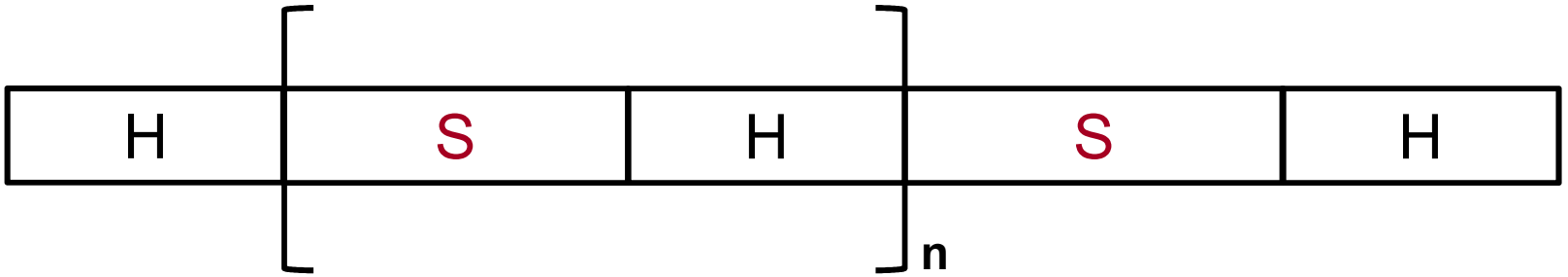
Waterborne Automotive Primer Surfacer (OEM).

Basic Structure of a Polyurethane Framework, High Elasticity.





(n < 50)

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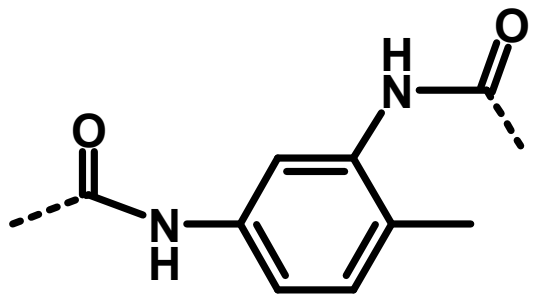
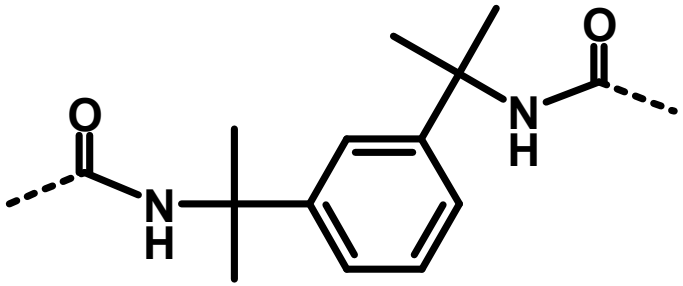
Waterborne Automotive Primer Surfacer (OEM).

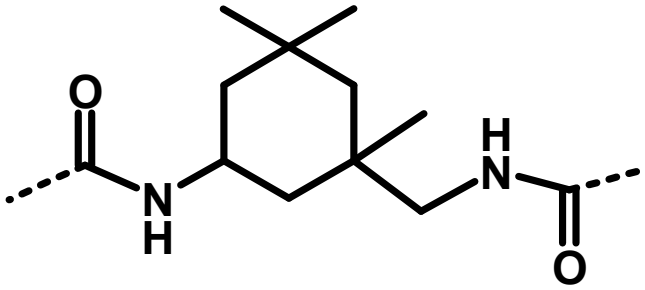
Basic Structure of a Polyurethane Resin, "Hard Segments" :



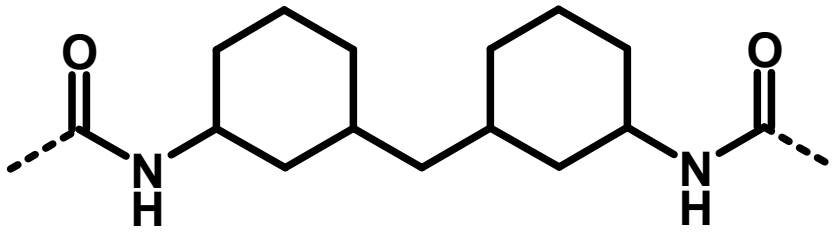
TDI



TMXDI



IPDI



H_{12} MDI

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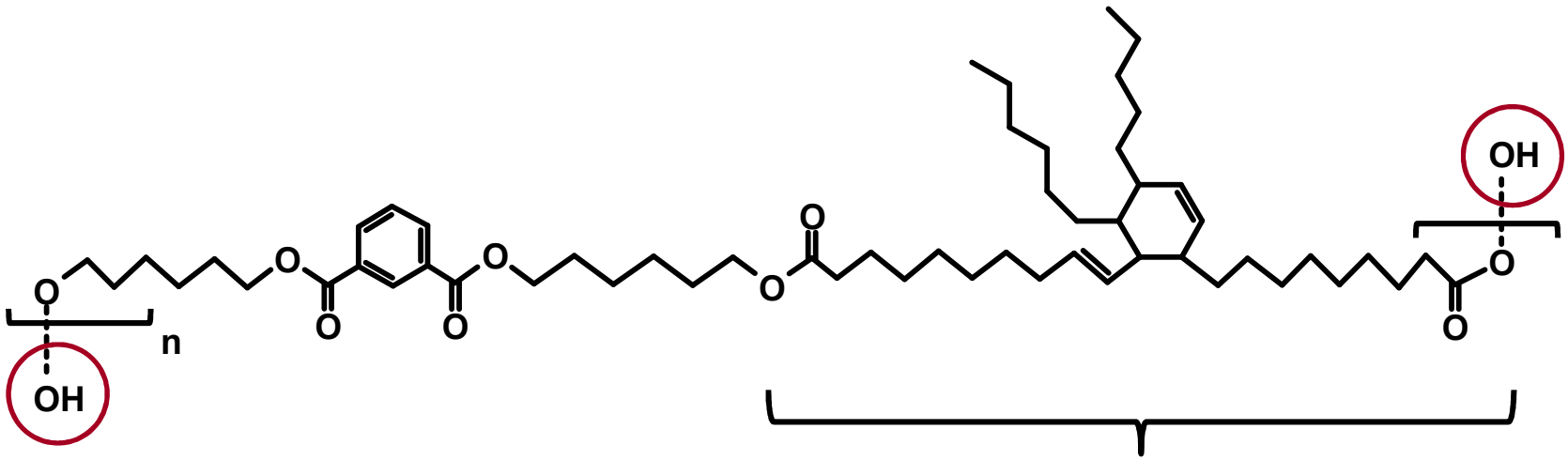
Waterborne Automotive Primer Surfacer (OEM).

Polyester Diol as "Soft Segment" of a Polyurethane Resin:



(n ≈ 1 – 10)

Dimeric fatty acid

Chemicals: E.g. Hexane diol-1,6; Isophthalic acid; Dimeric fatty acid.

Corresponds to the building block $HO-R_2-OH$ as “soft segment“ (Section).

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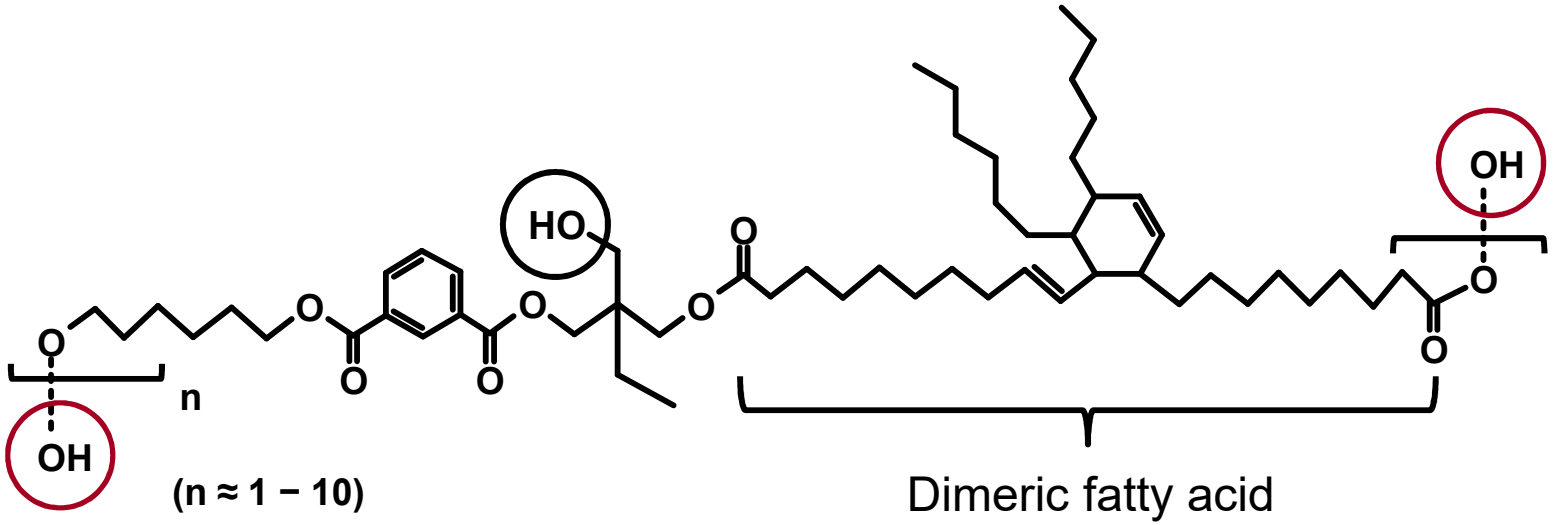
Waterborne Automotive Primer Surfacer (OEM).

Polyester Diol as "Soft Segment" of a Polyurethane Resin:



Chemicals: E.g. Hexane diol-1,6; Isophthalic acid; Dimeric fatty acid; 1,1,1-Trimethylol propane.

Corresponds to the building block HO−R_2−OH as "soft segment", OH-functionalized in the side chain.

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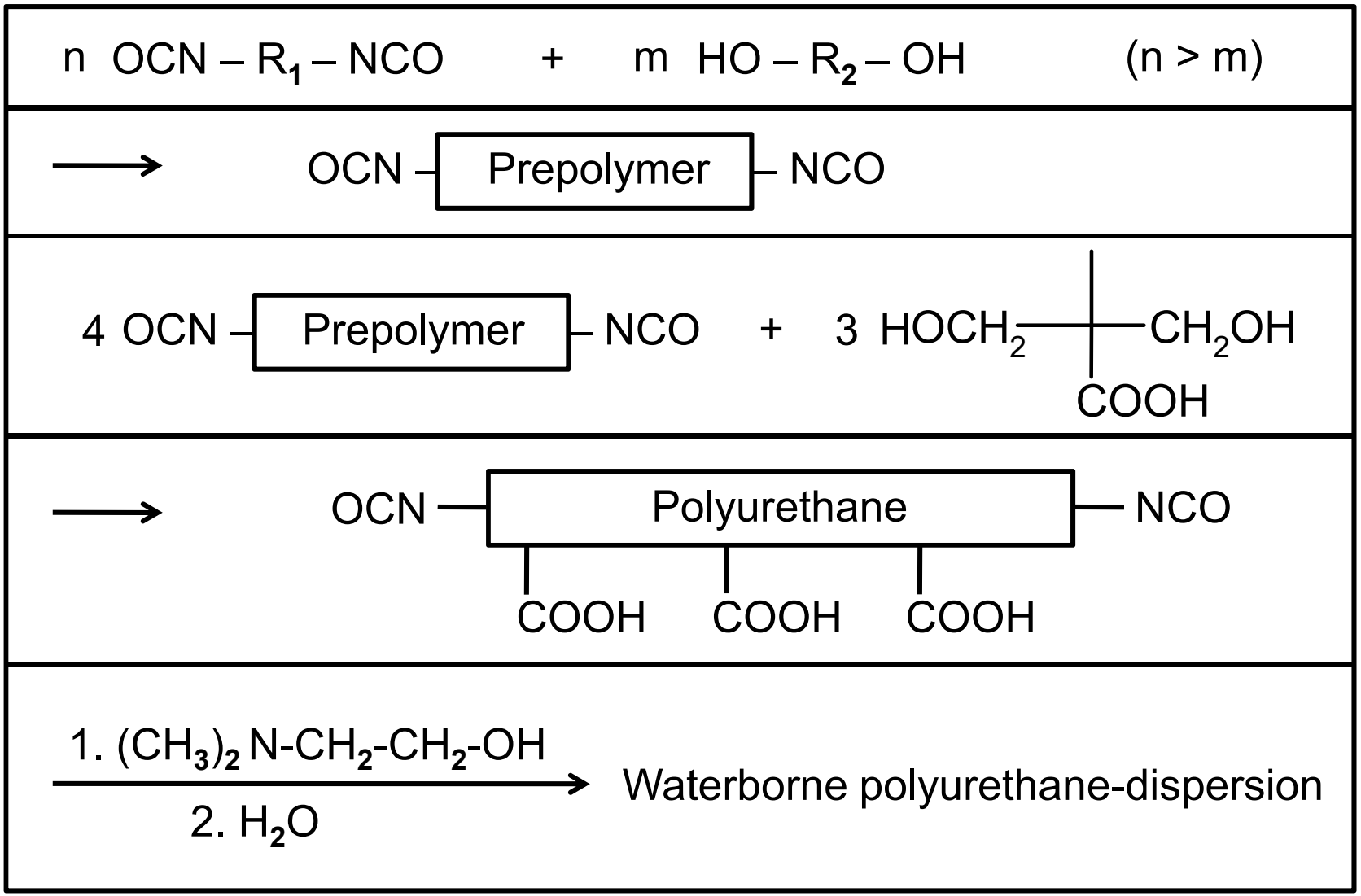
Waterborne Automotive Primer Surfacer (OEM).

Preparation of an Aqueous Polyurethane-Dispersion:



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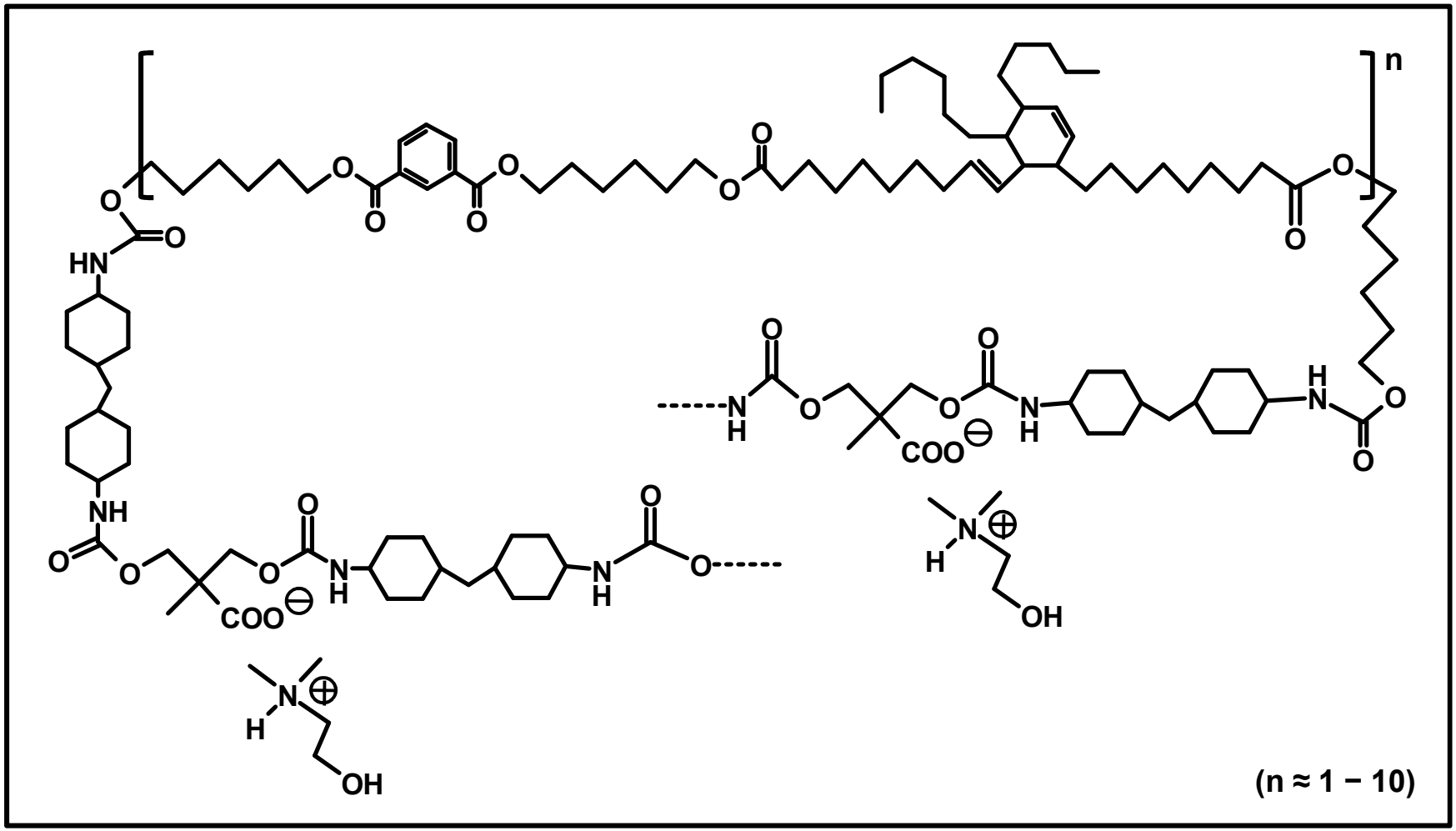
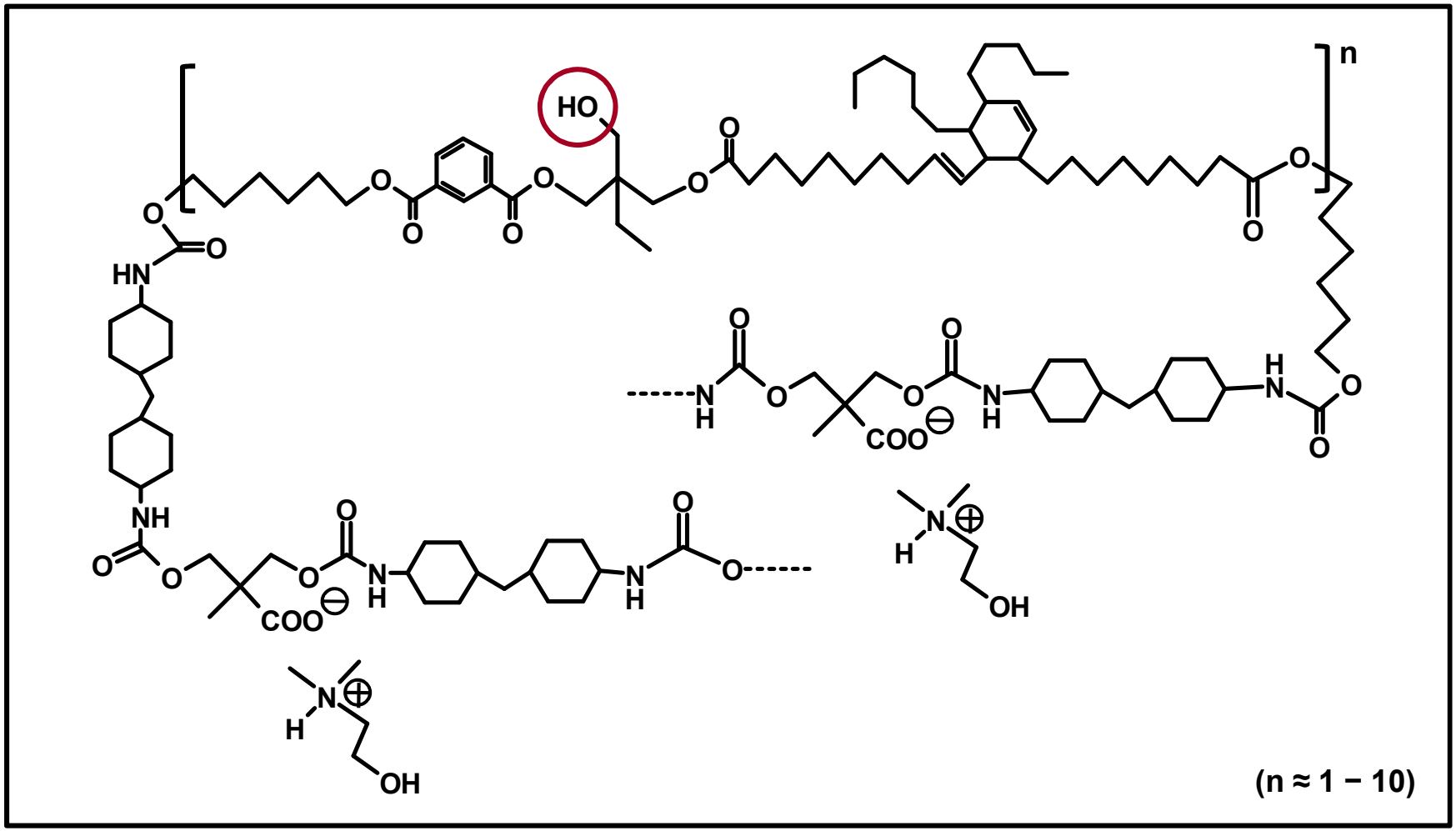
Waterborne Automotive Primer Surfacer (OEM).

Waterborne Polyurethane-Dispersion, Structural Section (Idealized):



Waterborne Automotive Primer Surfacer (OEM).

Waterborne OH-Polyurethane-Dispersion, Structural Section (Idealized):



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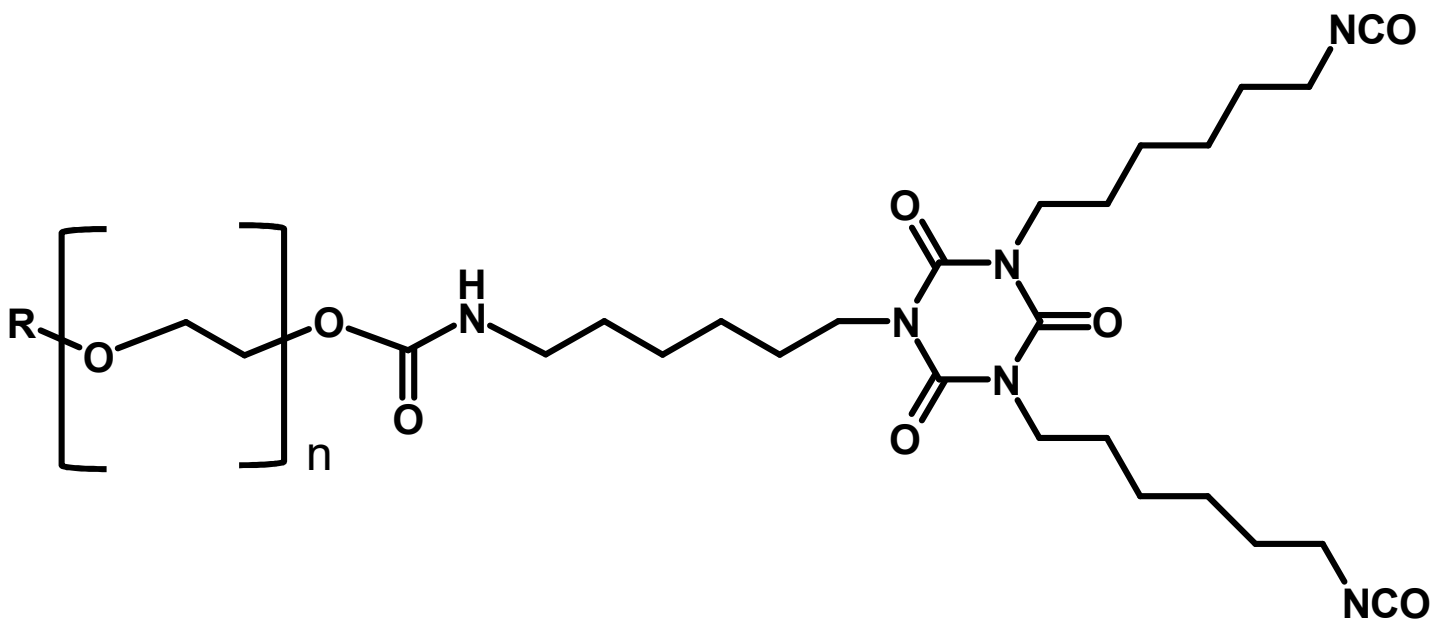
Waterborne Automotive Primer Surfacer (OEM).

Water-Dilutable Isocyanate-Crosslinker, Example:



R = H, C1-C3-Alkyl

n ≈ 10-30

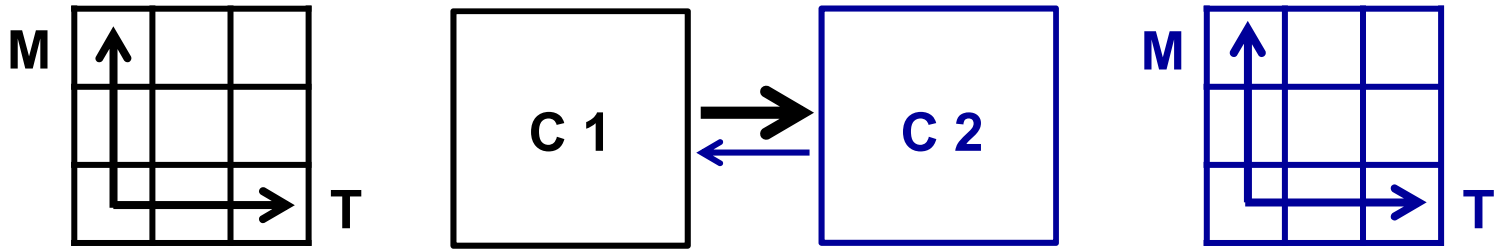
Innovations: Prerequisites for Market Success with the Process Variant explained here and its Characterization.

- "Correct" identification and translation of future production and market requirements.
- Own ability to "push" innovation onto the market against resistances.

→

Technology Leap

Own, basic R&D work for the effective exploitation of clearly new products and procedures. Consistency with the company market strategy is necessary.



M: Market Attractiveness

T: Technology Position

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Innovations, Process Variants.

Example

- "Correct" identification and translation of future production and market requirements.
- Own ability to "push" innovation onto the market against resistances.

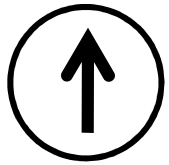
→

Technology Leap

Own, basic R&D work for the effective exploitation of clearly new products and procedures. Consistency with the company market strategy is necessary.

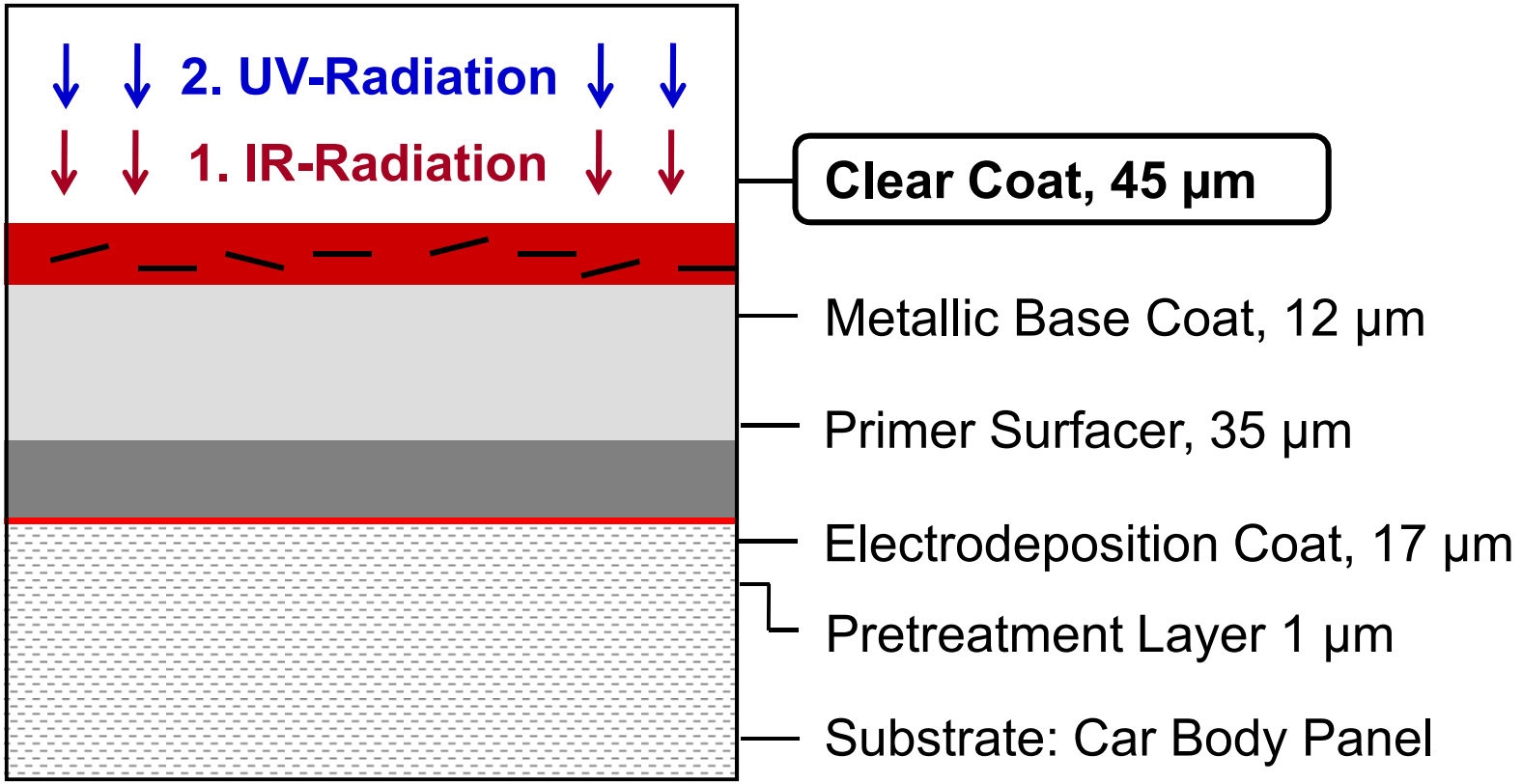
New, IR-/UV-curing varnish for transparent topcoats from automotive (OEM) with hitherto not achieved resistance to scratch damages. Own, patented polymer and initiator combinations. Use of new, "cold" LED-UV lamps (AlGaInN) for curing.

Strategy: Increase of the market share for clear lacquers.



Four-Layer Automotive Coating (OEM).

IR-/UV-Cured Clear Coat with a Loss Modulus > 30 MPa.



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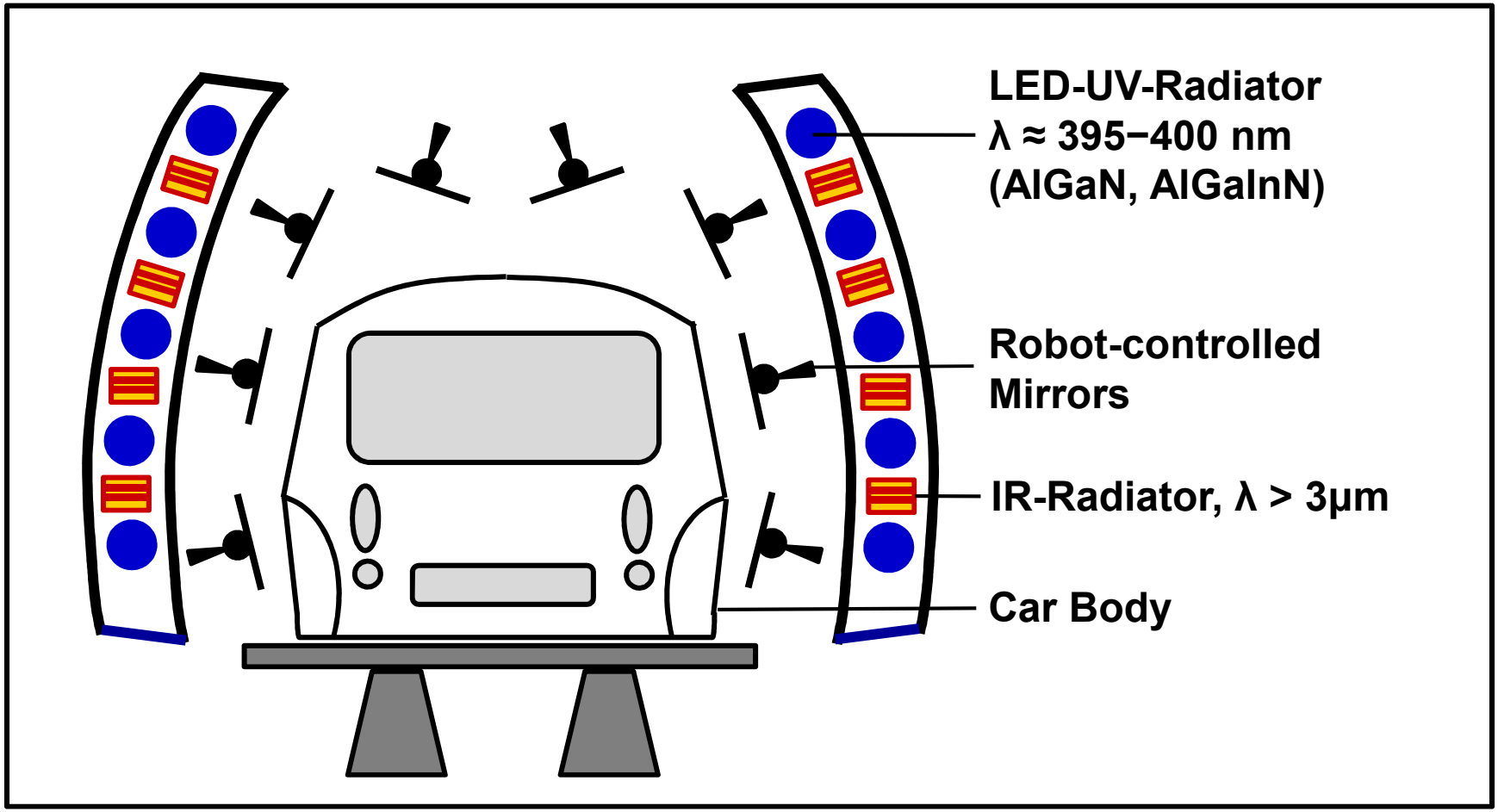
Four-Layer Automotive Coating (OEM).

IR-/UV-Curable Clear Coat: Application in the Painting Line.



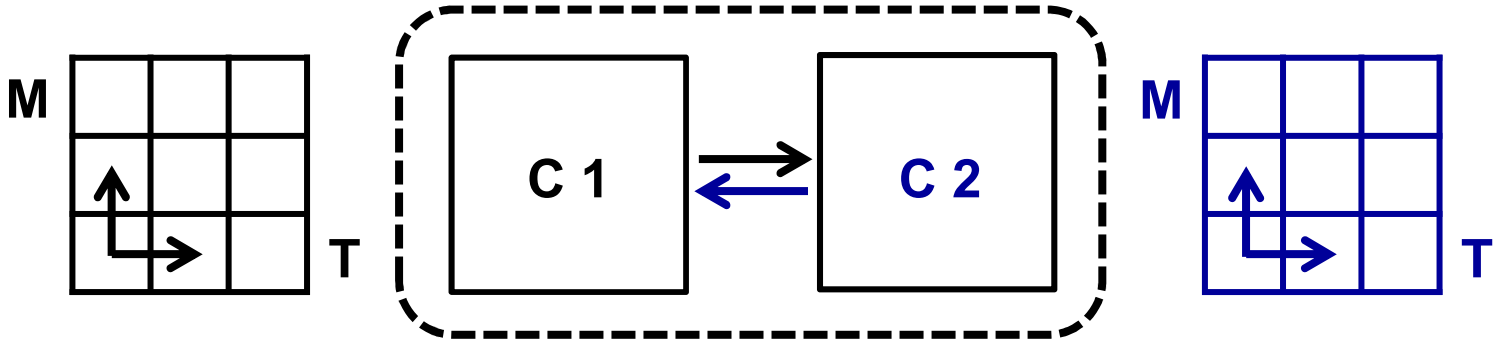
Innovations: Prerequisites for Market Success with the Process Variant explained here and its Characterization.

- Complementary, sound (technical) competencies.
- Ability to form partnerships.
- Solid own position.

→

Technology Partnership

Development project with mutual and continuous "normal" technical input. Possibility of a joint market introduction via discrete sales channels.



M: Market Attractiveness

T: Technology Position

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Innovations, Process Variants.

Example

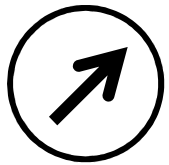
- Complementary, sound (technical) competencies.
- Ability to form partnerships.
- Strong own position.

→

Technology Partnership

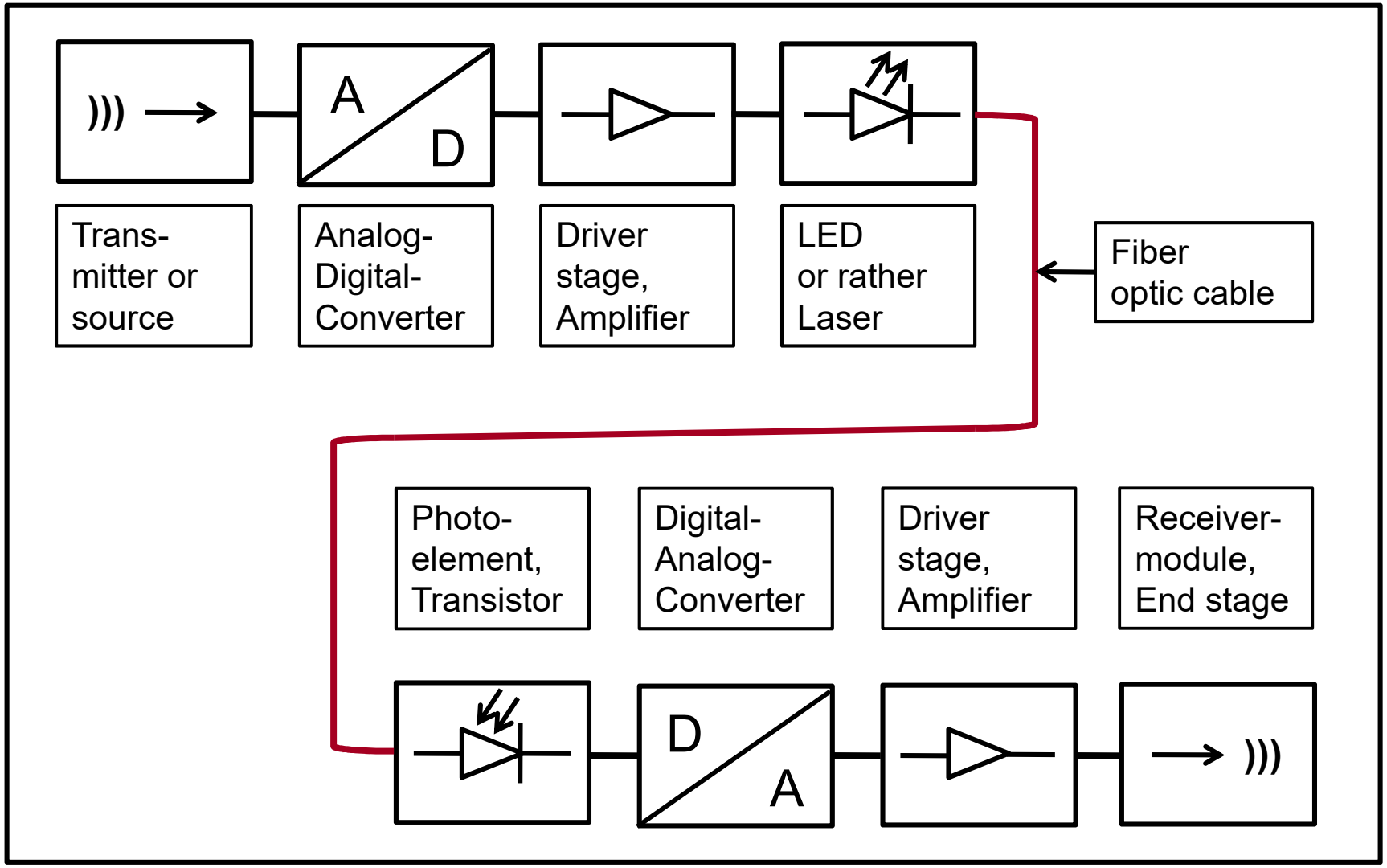
Development project with mutual and continuous "normal" technical input. Possibility of a joint market introduction via discrete sales channels.

Development of transparent lacquers for the primary coating of high-performance glass fibers with optimized refractive indices (Fiber optic cables, FOC). Planned cooperation with an optoelectronics firm. Target markets: Fiberglass coatings of optical waveguides for medical technology and sensor technology.



Primary Coatings of High Performance Glass Fibres.

Optical Transmission System Based on Fiber Optic Cables:



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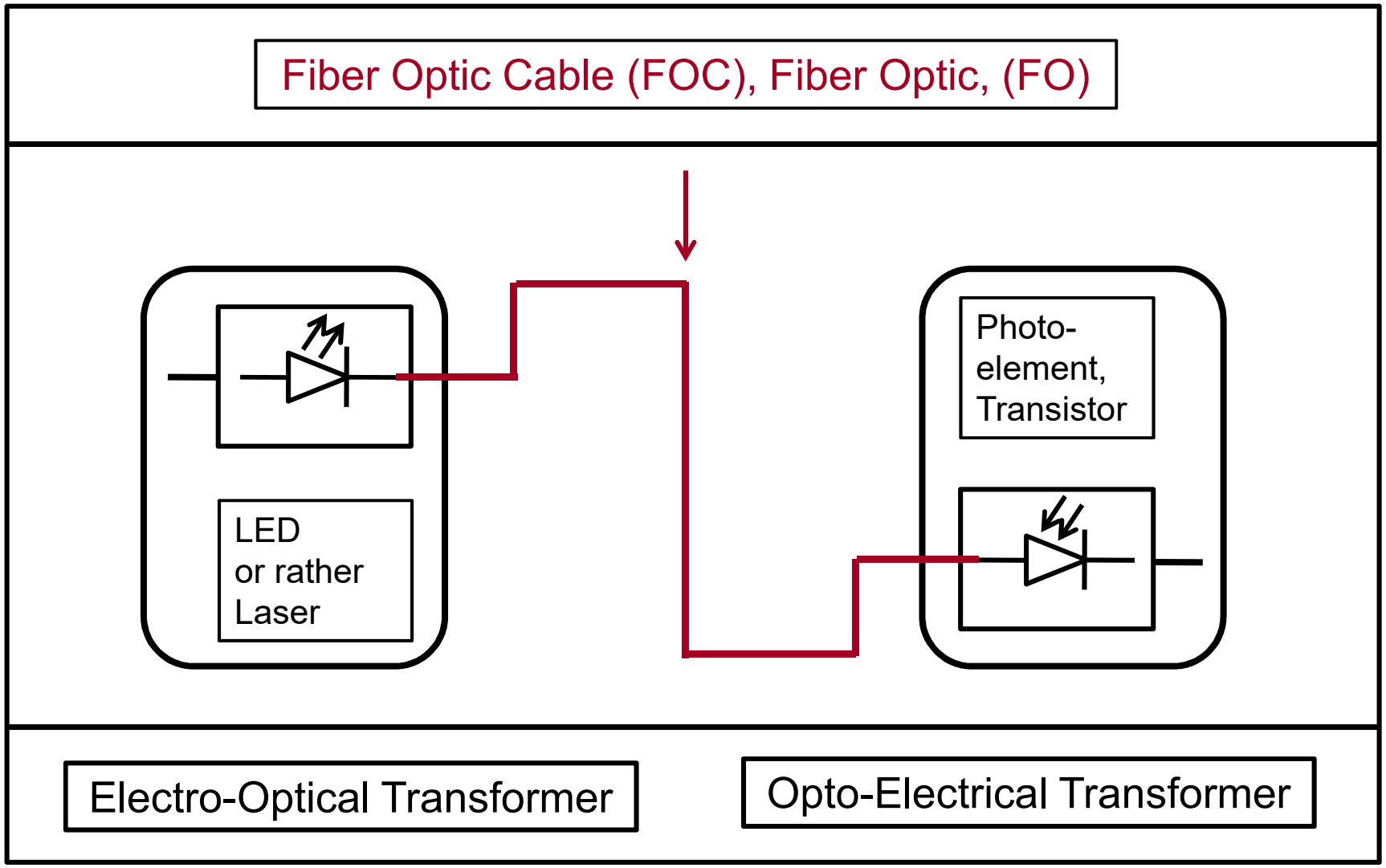
Primary Coatings of High Performance Glass Fibres.

Optical Transmission System Based on Fiber Optic Cables:



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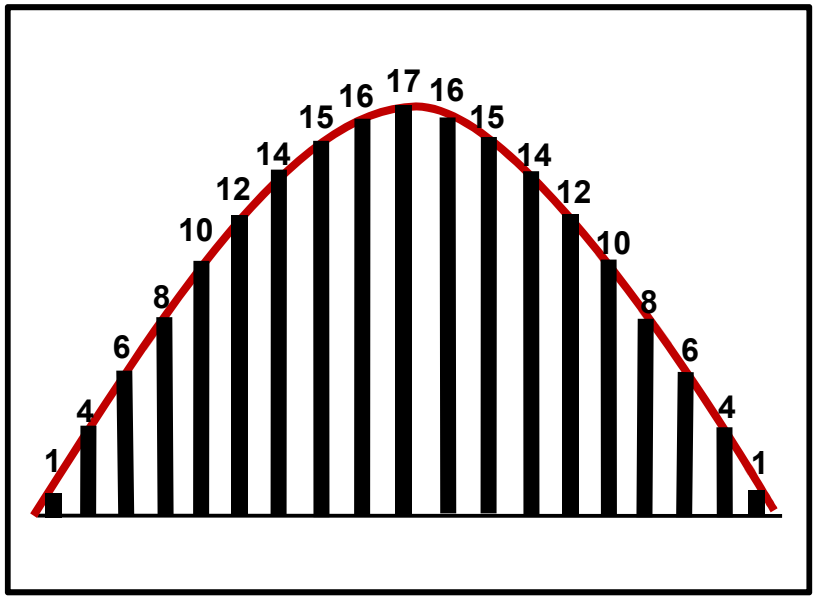
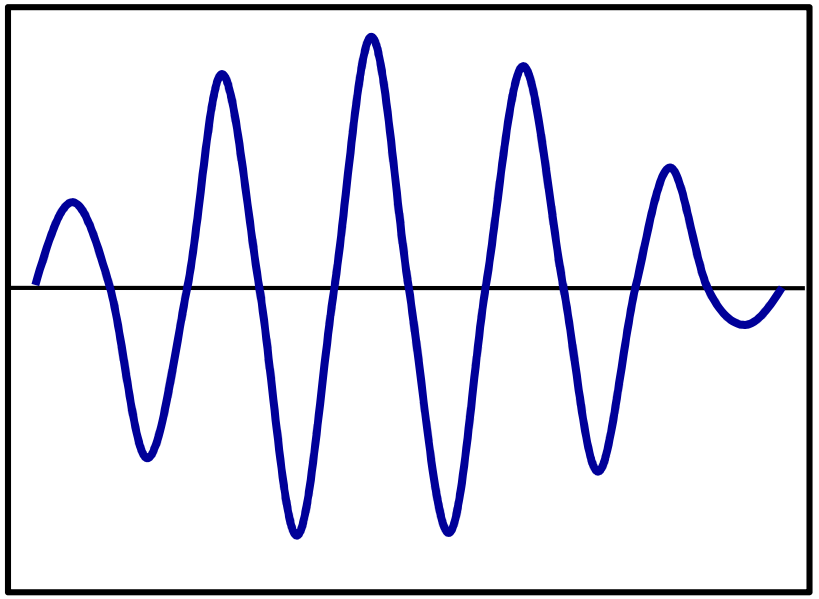
Primary Coatings of High Performance Glass Fibers.

Light Waves: Analog-Digital-Conversion, Amplitude Modulation:





Analog-Digital-Conversion

Amplitude Modulation

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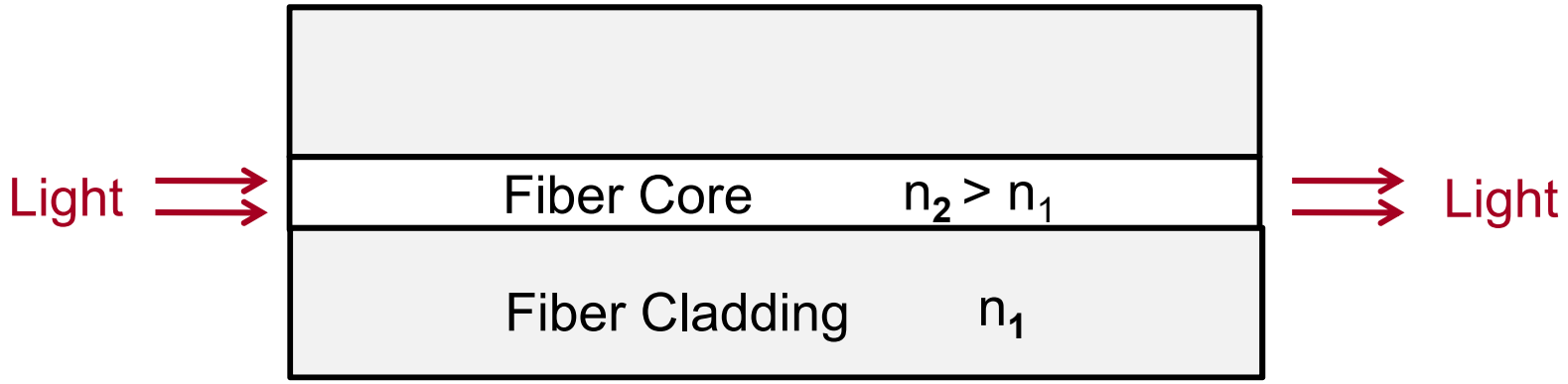
Primary Coatings of High Performance Glass Fibers.

Composition of Core and Cladding:

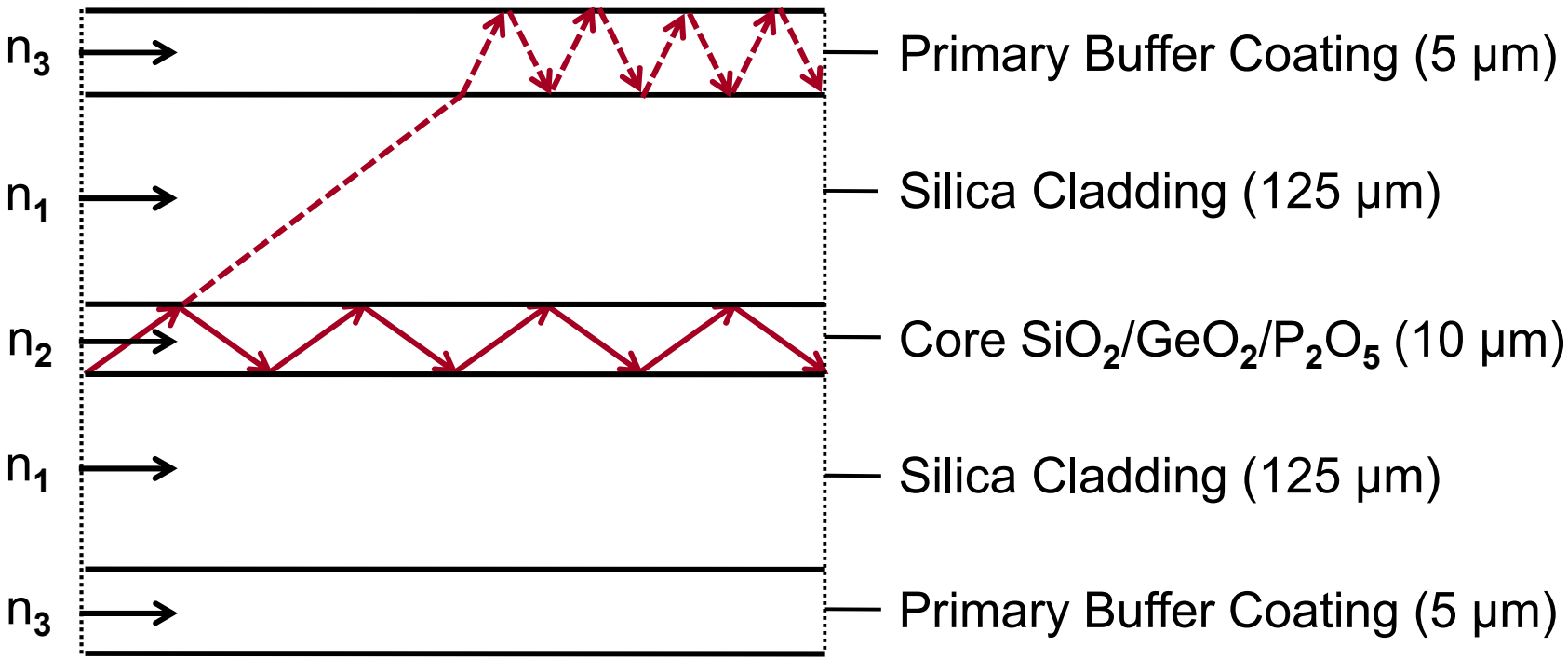


LWL Type 1 ⟶ Core: SiO_2 (+ GeO_2 + P_2O_5) / Cladding: SiO_2

LWL Type 2 ⟶ Core: SiO_2 / Cladding: SiO_2 (+ B_2O_3 + NaF)

Primary Coatings of High Performance Glass Fibers.

Step-Index Profile, Functional Principle: "Deduction" of the Scattered Light by Means of the "Primary Buffer Coating".



$n_2 > n_1$ und $n_3 > n_1$

Loss of light, using high performance glass fibers: ~ 0,2dB/km (~ 5%)

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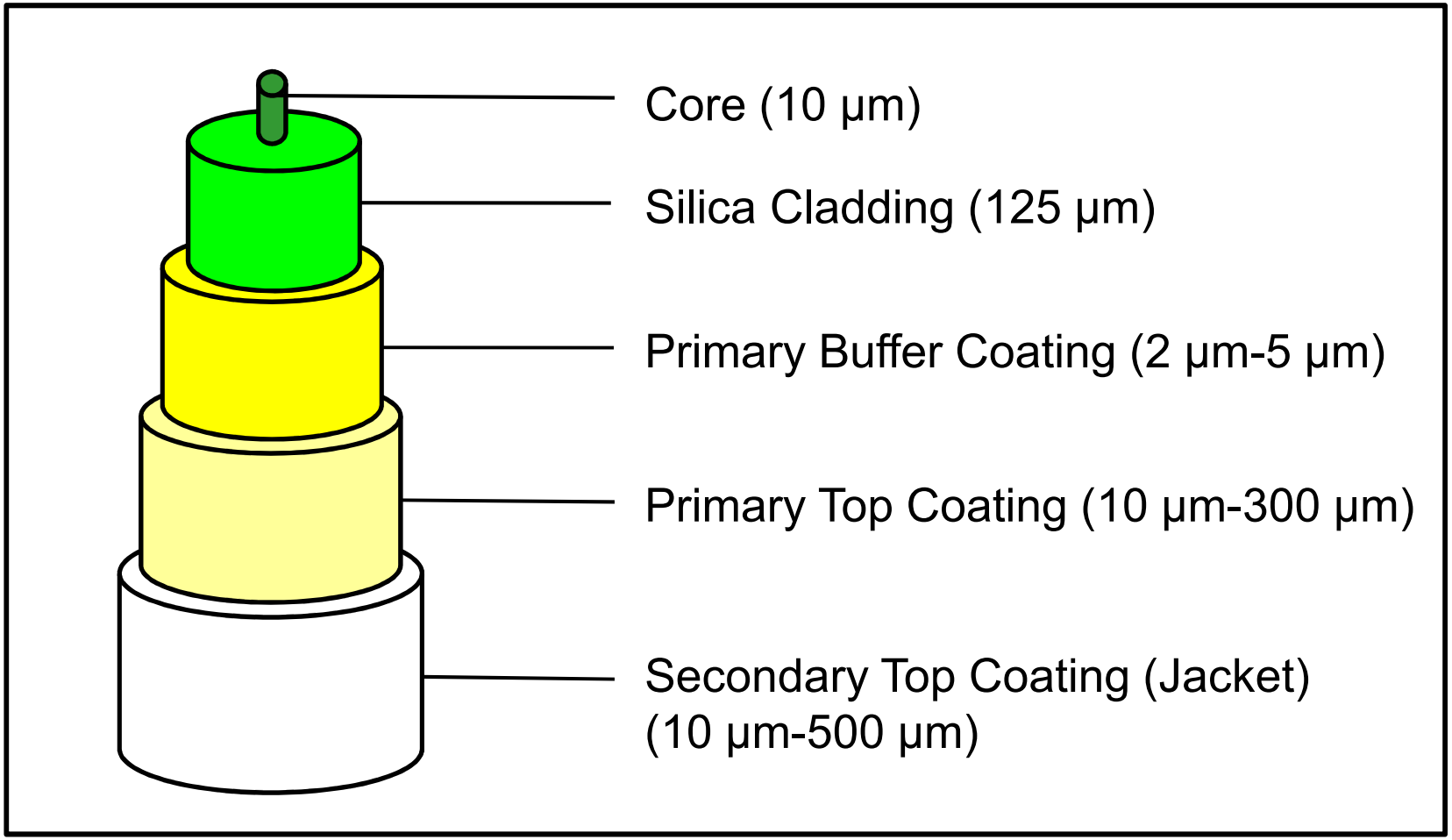
Primary Coatings of High Performance Glass Fibers.

Glass Fiber: Structure of a Step-Index Profile Fiber:



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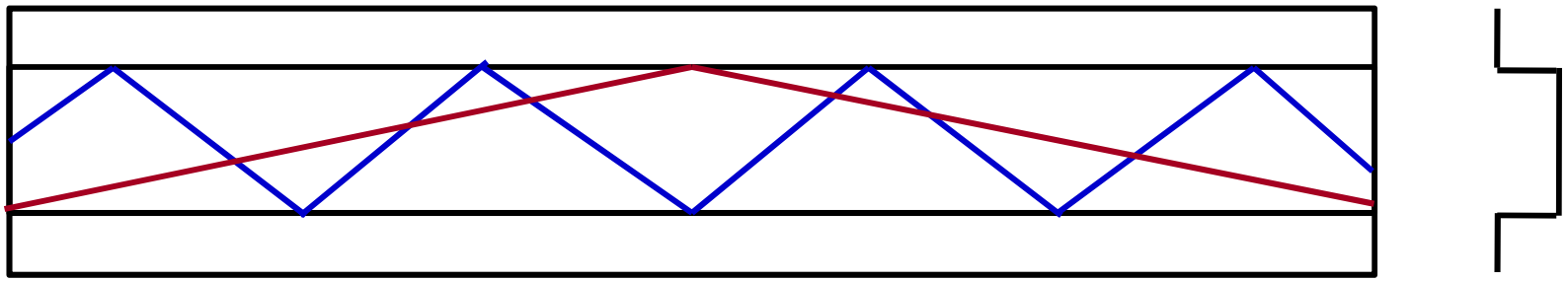
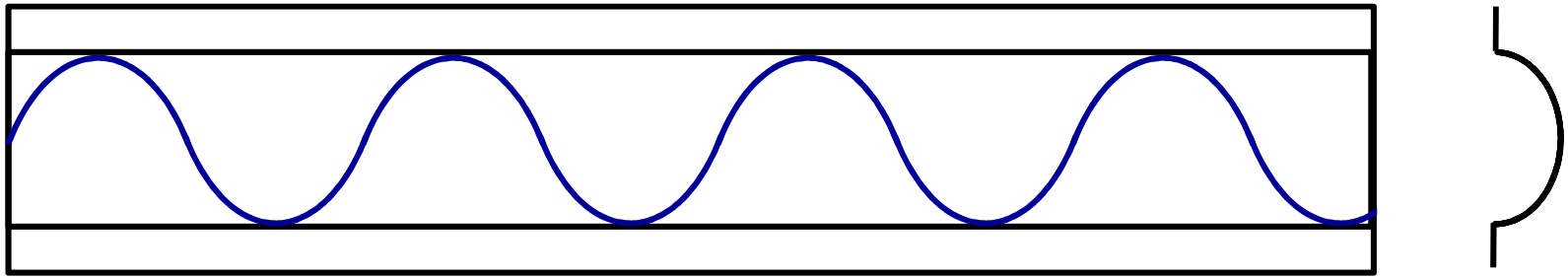
Primary Coatings of High Performance Glass Fibers.

Light-Conducting Fibers: Different Fiber Types, Profiles:

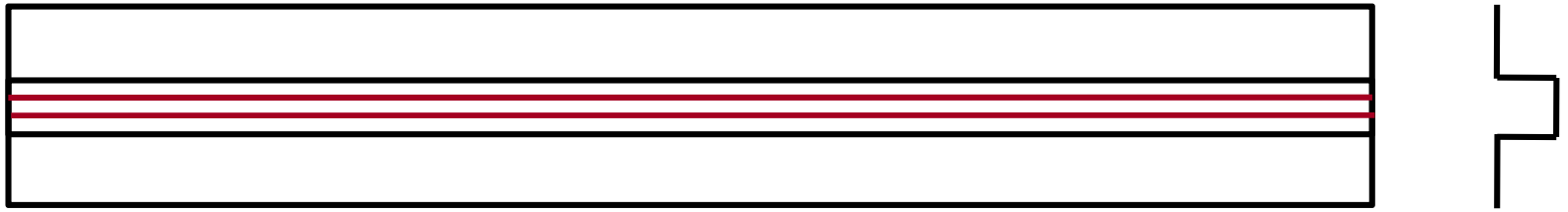
Step Index Fiber



Gradient Index Fiber



Single Mode Fiber



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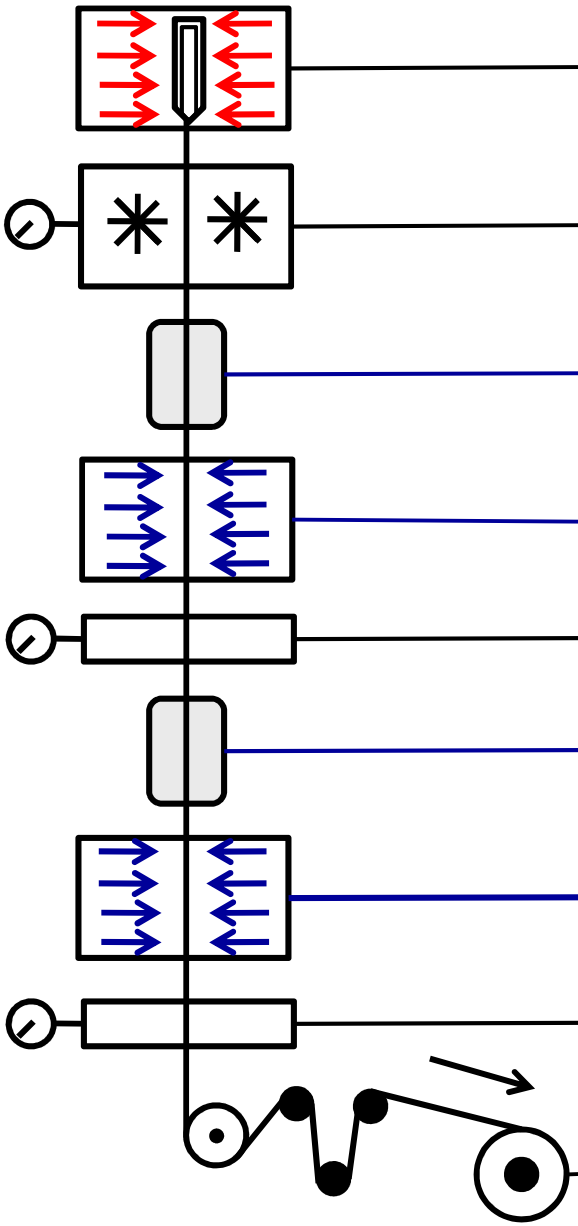
FOC-Drawing Tower



Elements of its Basic Structure:

- High Temperature Drawing Tower (≈ 2.200°C)
- Cooling Zone and Diameter Measurement
- Primary Buffer Coating, Liquid Bath
- Curing by means of an UV-Radiator (≈ 100°C)
- Diameter-, Eccentricity-Measurement
- (Primary) Top Coating, Liquid Bath
- Curing by means of an UV-Radiator (≈ 100°C)
- Diameter-, Eccentricity-Measurement
- Fiber Finish: Spools to wind the Optical Fiber

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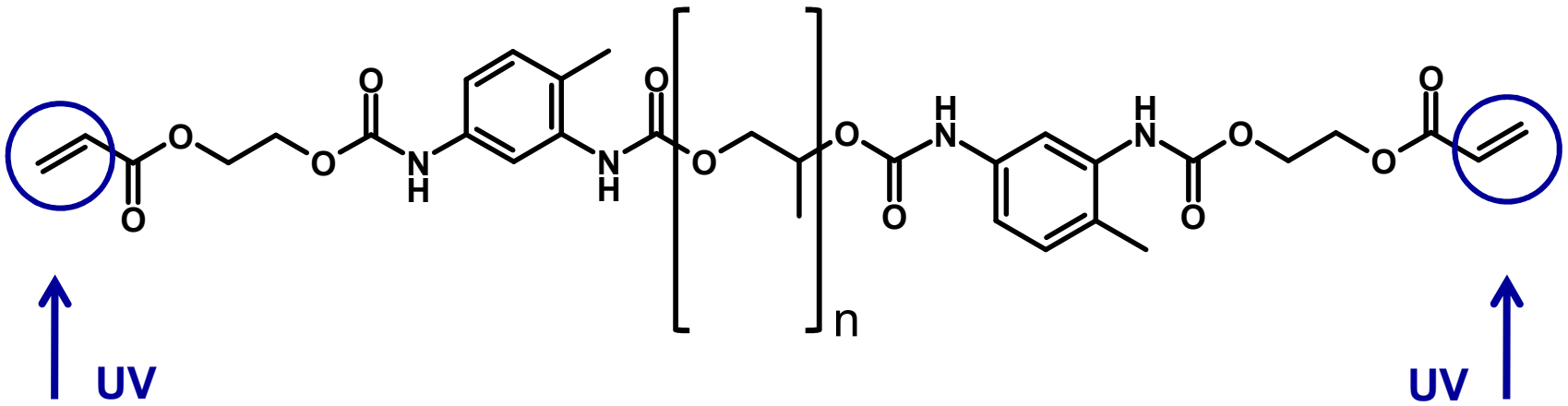
Primary Coatings of High Performance Glass Fibers.

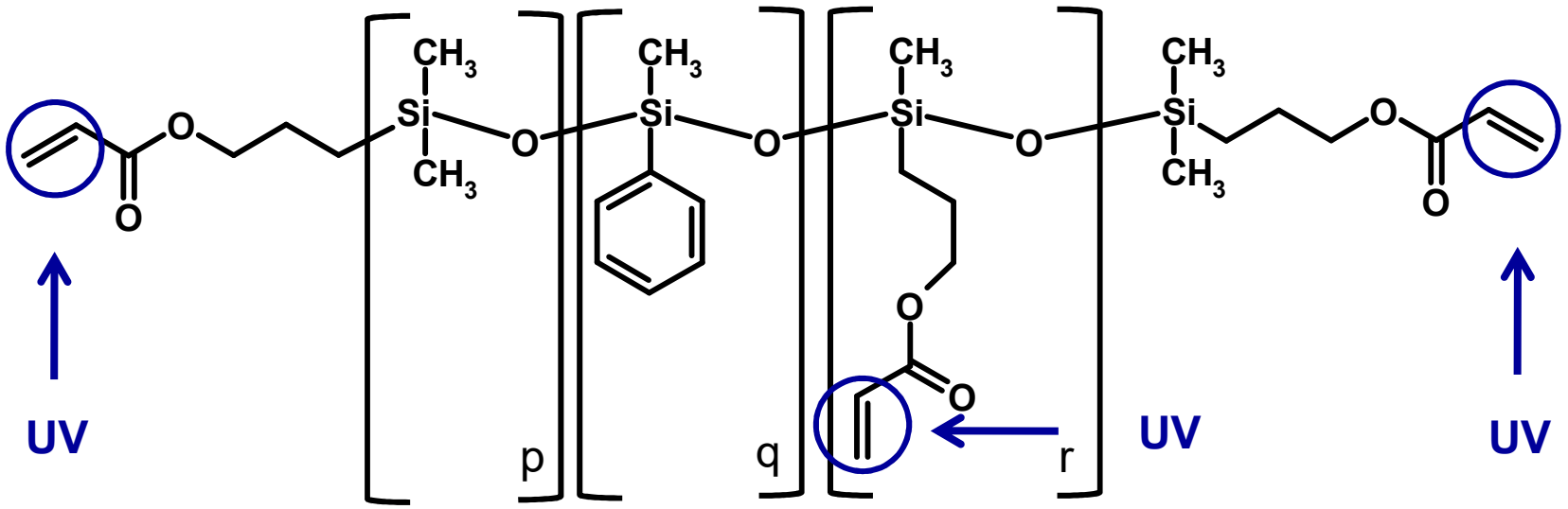
"Primary Buffer Coating": UV-Curable Polyurethane-Acrylate.



n ≈ 60 – 160 (Idealized Structure)

Primary Coatings of High Performance Glass Fibers.

"Primary Buffer Coating": UV-Curable Polysiloxane-Acrylate.



p ≈ 160; q ≈ 120; r ≈ 18 (Idealized Structure)

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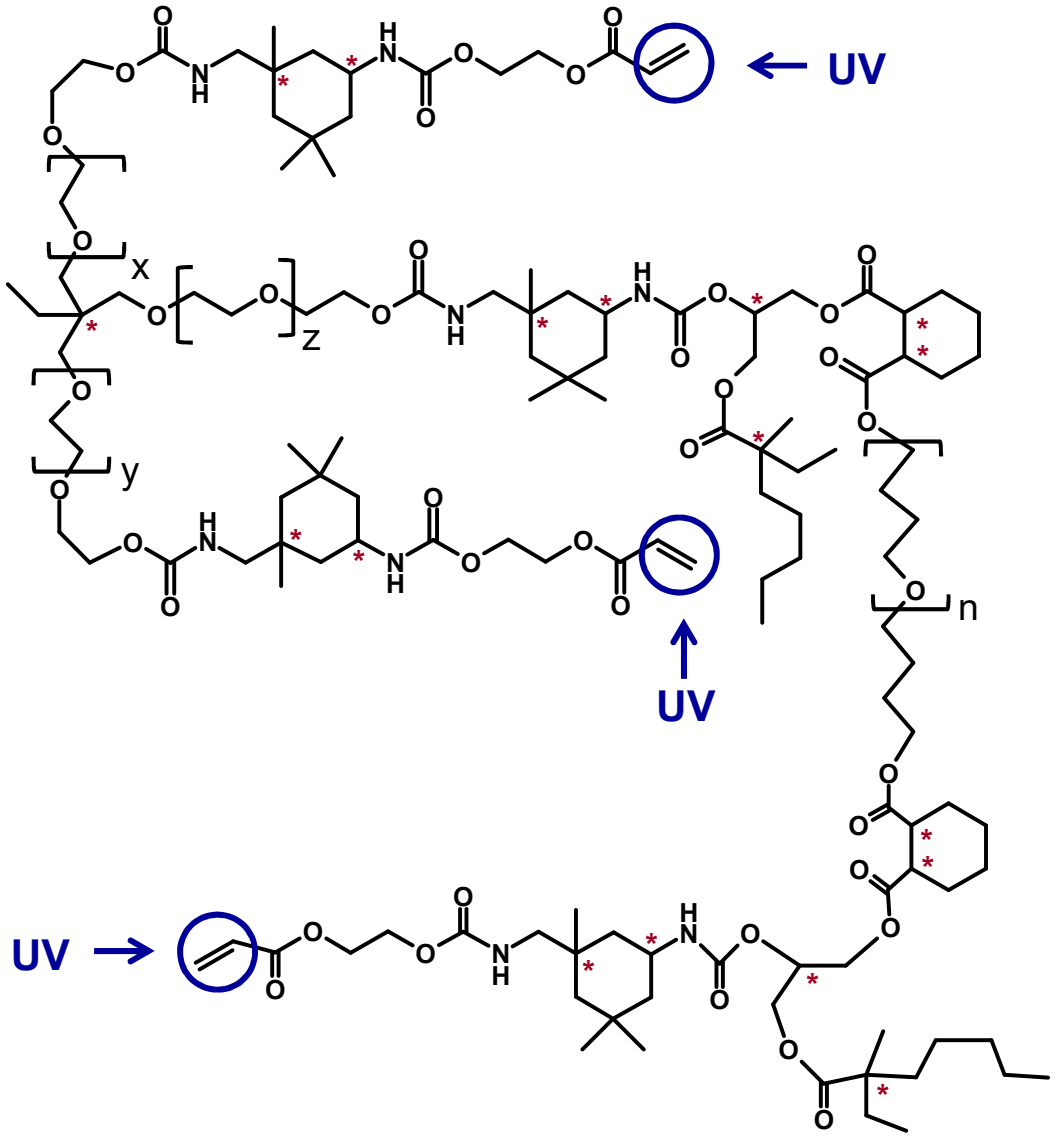
Primary Coatings of High Performance Glass Fibers.

"Primary Top Coating" : UV-Curable Polyurethane-Acrylate.



* Asymmetric Center

≈ 131.072 possible Diastereomers (2^{17})!

↓

Very Important: No Microcristallization!

X + Y + Z ≈ 17

n ≈ 10 – 15

(Idealized Structure; Glass-like consistency of the coating cured with UV light!)

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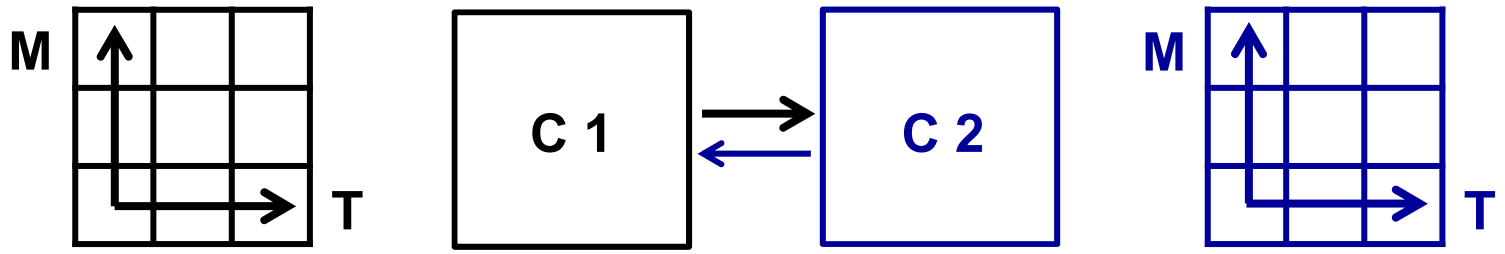
Innovations: Prerequisites for Market Success with the Process Variant explained here and its Characterization.

- High technical competence.
- Transdisciplinary thinking and acting.
- Effective global information management and active "Technology-Scouting".

→

Imitation Concept

2nd-follower strategy:
Rapid transformation and adaptation of leading technologies from *other* industries ("Best Practice Solutions"), especially for the own market.



M: Market Attractiveness | **T**: Technology Position

Innovations, Process Variants.

Example

- High technical competence.
- Transdisciplinary thinking and acting.
- Effective global information management and active "Technology-Scouting".

→

Imitation Concept

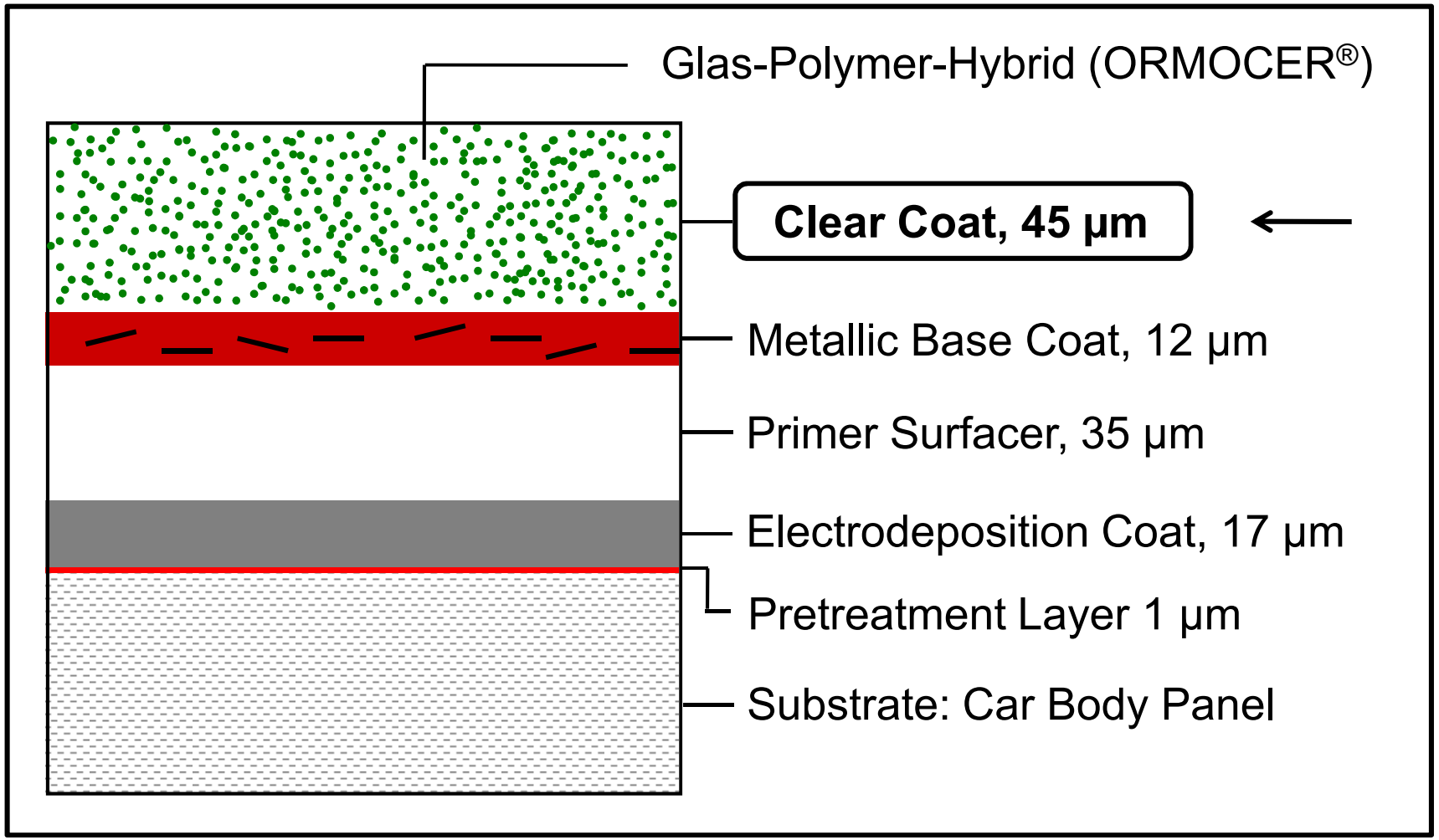
2nd-follower strategy:
Rapid transformation and adaptation of leading technologies from *other* industries ("Best Practice Solutions"), especially for the own market.

Development of an own system, basing on sol-gel materials for automotive clear coats (OEM).

Adaptation of the hitherto developed technology for the production of scratch-resistant coated lenses made of plastics (Successful application in the ophthalmic lens industry).

Four-Layer Automotive Coating (OEM), 2020.

Scratch-Resistant Clear Coat Using Sol-Gel Application:



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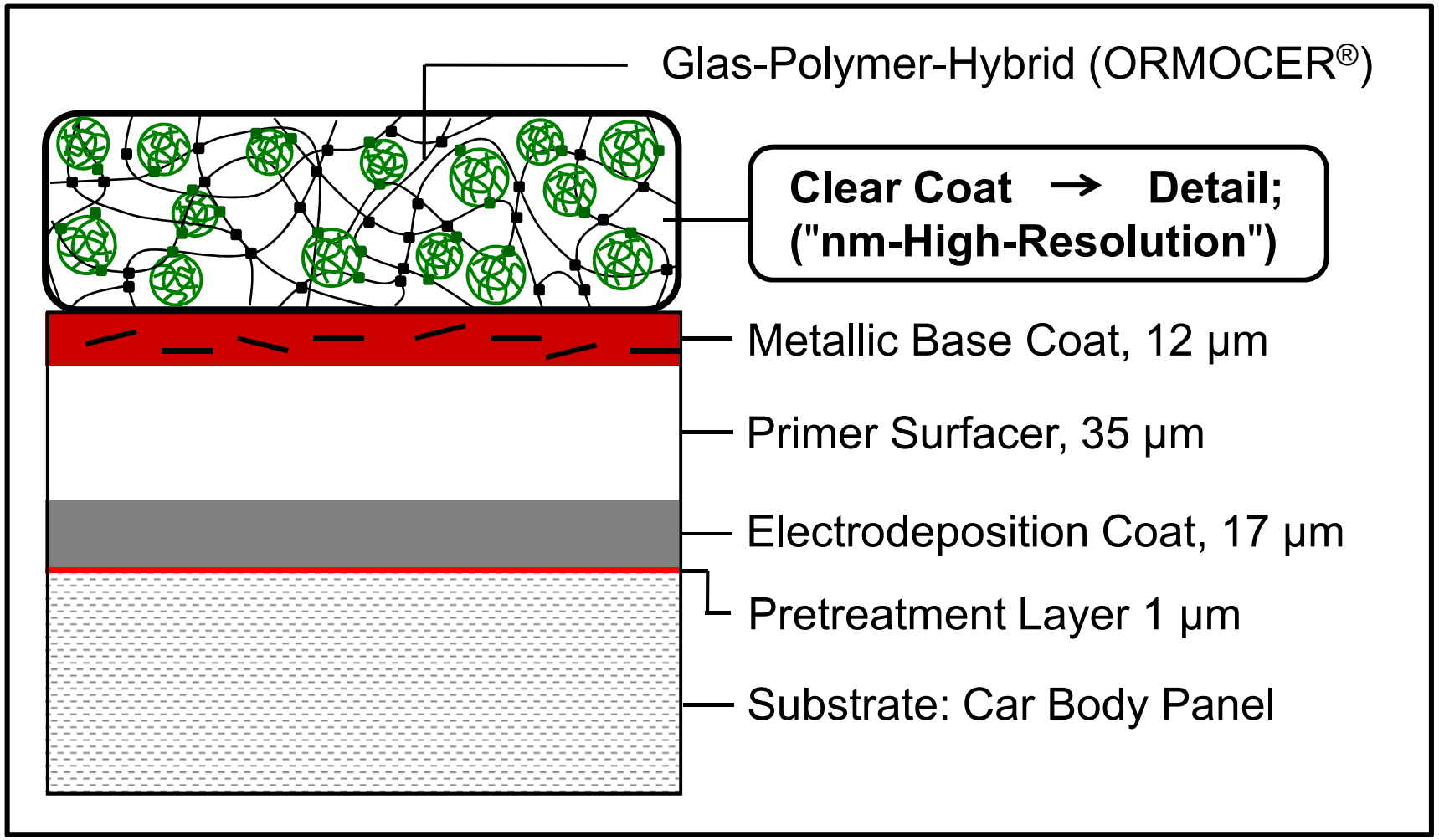

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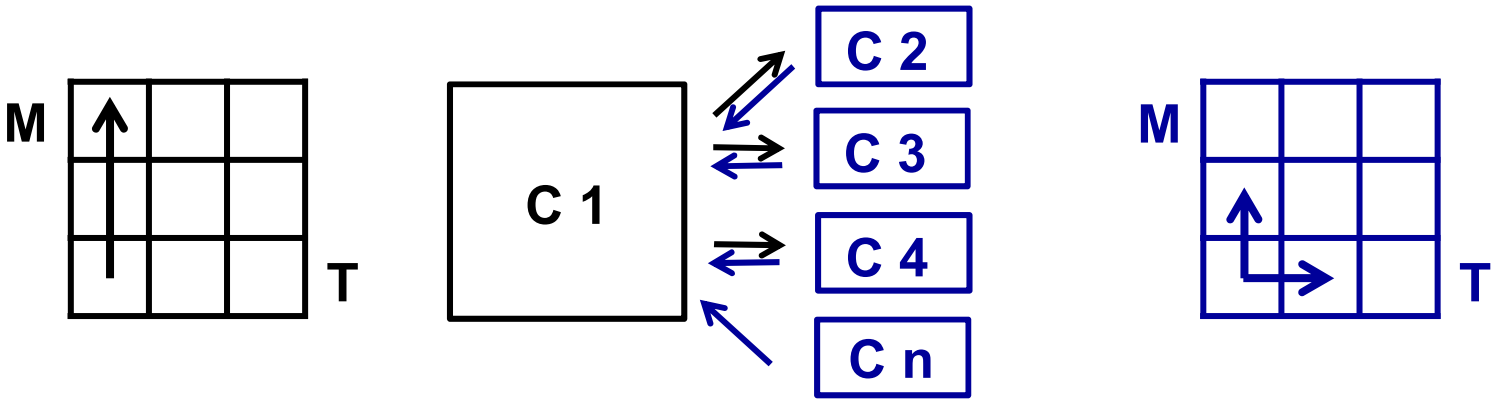
Innovations: Prerequisites for Market Success with the Process Variant explained here and its Characterization.

- Broad and fundamental technical know-how. Good market knowledge.
- Speed and flexibility.
- High product quality and reliability as a supplier.

→

Own Modular System

Flexible platform or module concept for as many different customers as possible (and their "supply chain" backup). No exclusivity.



M: Market Attractiveness

T: Technology Position

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Innovations, Process Variants.

Example 1

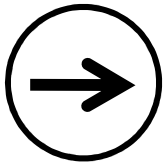
- Broad and fundamental technical know-how.
  Good market knowledge.
- Speed and flexibility.
- High product quality and reliability as a supplier.

→

Own Modular System

Flexible platform or module concept for as many different customers as possible (and their "supply chain" backup).
No exclusivity.

Development of a variable, IT and colorimetric-supported mixing shelf system with fifty customized basic colors for the supply to automotive refinish paint shops in various regions. Use of color space software to create recipes for standard colors and special or effect colors.



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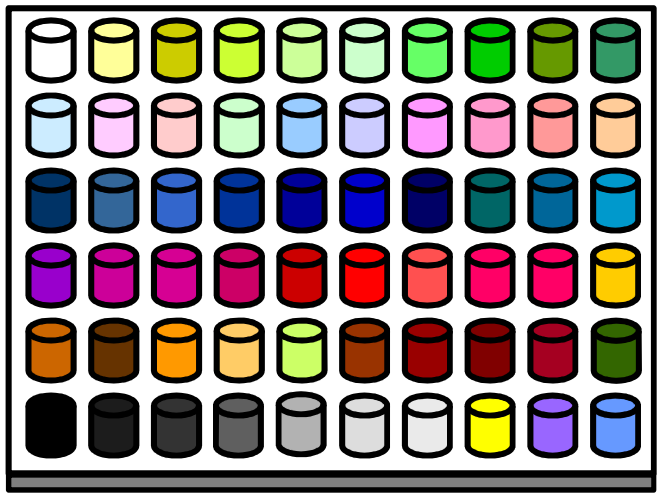
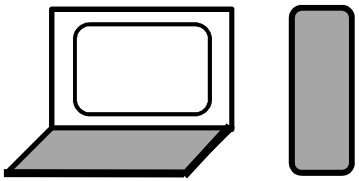
Four-Layer Automotive Coating (OEM), 2015.

Base Coat: Color Shades According to the Given Trends.

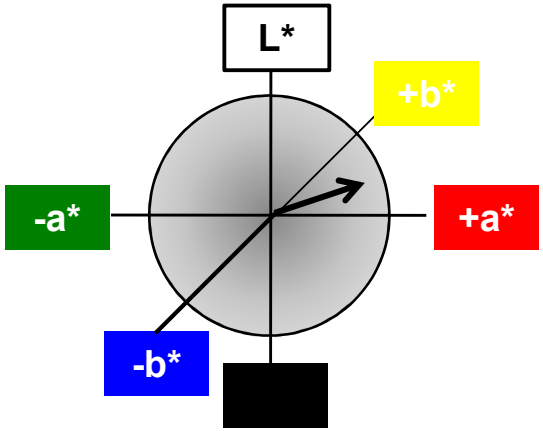


Mixing shelf



PC for Calculation of the
Mixing Formulas/Recipes

Multi-Angle Spectrophotometer



L*a*b*-Color Space

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Innovations, Process Variants.

Example 2

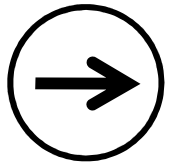
- Broad and fundamental technical know-how.
  Good market knowledge.
- Speed and flexibility.
- High product quality and reliability as a supplier.

→

Own Modular System

Flexible platform or module concept for as many different customers as possible (and their "supply chain" backup).
No exclusivity.

Development of combinable paint and paste systems for the supply of different automobile manufacturers. Rapid and flexible realization of specific, perfectly fitting four-layer coatings on different metal substrates, such as phosphated steels, galvanized steels or (chromated) aluminum alloys.



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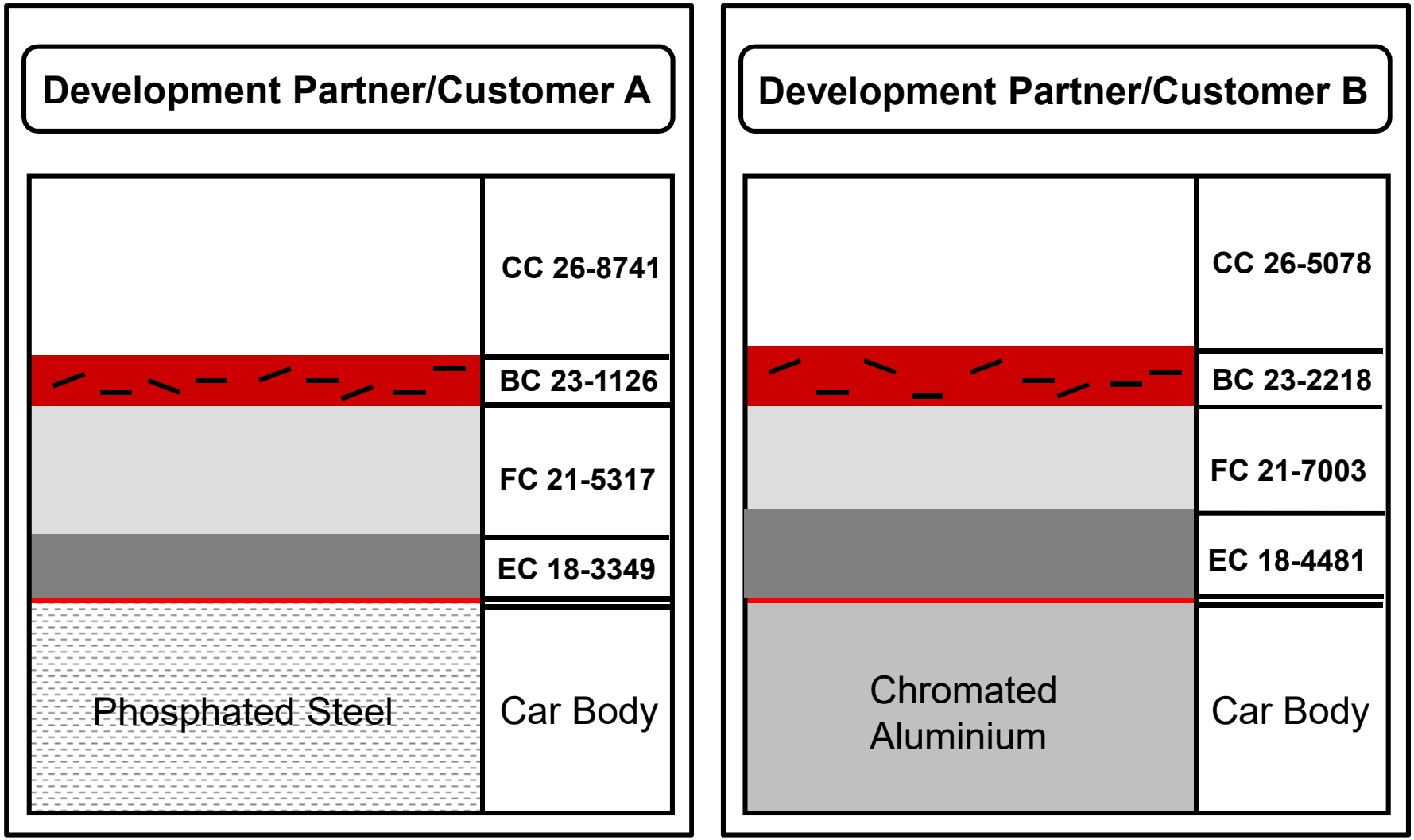
Four-Layer Automotive Coating (OEM), 2020.

Individual Coating Structures for Different Pilot Customers:



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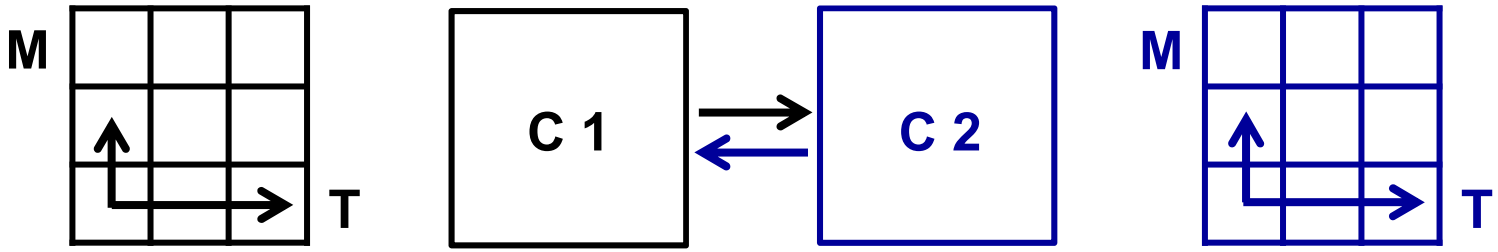
Innovations: Prerequisites for Market Success with the Process Variant explained here and its Characterization.

- Competent, customer-oriented technical team.
- Speed, flexibility, effective information management.
- Presence in very specific regional markets and their requirements.

→

Taylor-Made Solutions

Customized innovations for niche markets to meet special customer requirements.
No exclusivity.



M: Market Attractiveness

T: Technology Position

Innovations, Process Variants.

Example

- Competent, customer-oriented technical team.
- Speed, flexibility, effective information management.
- Presence in very specific regional markets and their requirements.

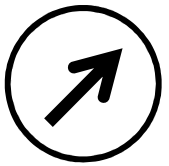
→

Taylor-Made Solutions

Customized innovations for niche markets to meet special customer requirements.
No exclusivity.

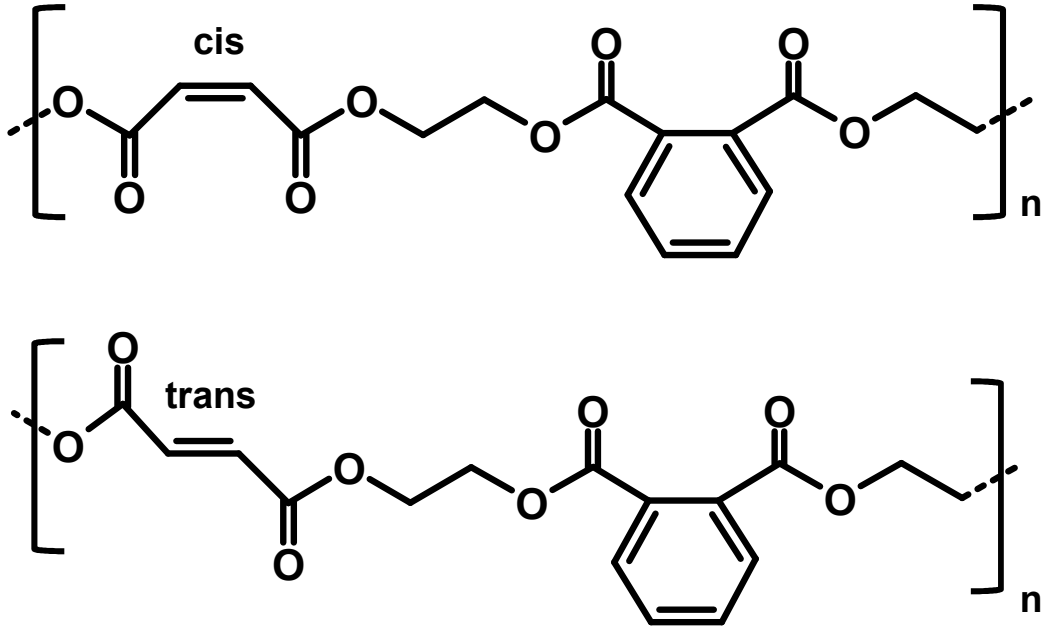
Development of special clear coats for the finishing of automobile parts made of Asian or South American precious hardwoods (In particular root wood).

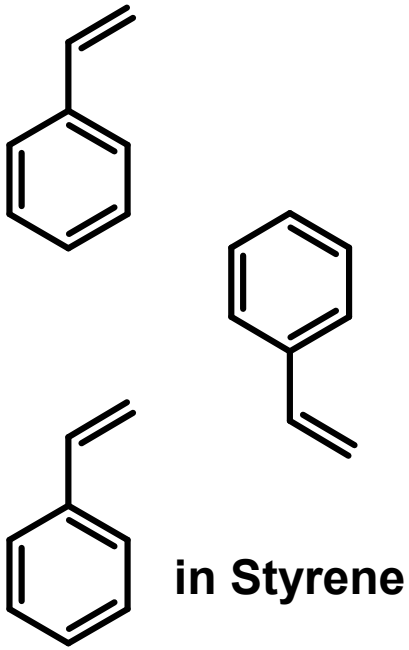
Examples: Buttons of gear levers or cockpit panels in luxury limousines from exclusive automakers.



Special Clear Coat for Niche Applications (OEM), Liquid

Repeatedly Painted Wooden Parts for Premium Car Brands:





Ferrari®	ASTON MARTIN®	MAYBACH®	MASERATI®
Lamborghini®	PORSCHE®	JAGUAR®	ROLLS ROYCE®
BUGATTI®			

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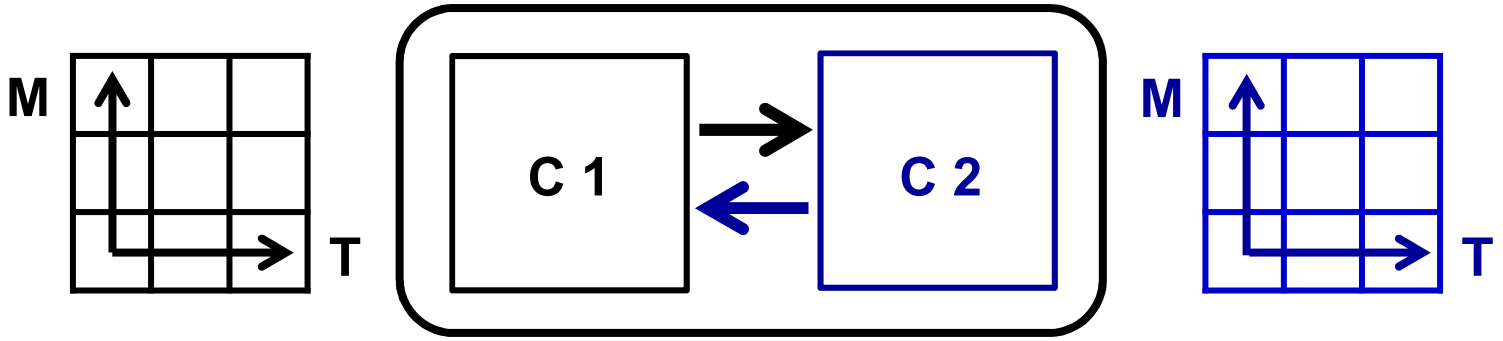
Innovations: Prerequisites for Market Success with the Process Variant explained here and its Characterization.

- Excellent and unique, in each case complementary technical competencies.
- Close partner relations, mutual trust, contractual fidelity.

→

Exclusive Partnership

Joint R & D work in the form of a contracted joint venture. Use of the respective, highly specialized competences of both partners. Strict exclusivity!



M: Market Attractiveness | **T**: Technology Position

Innovations, Process Variants.

Example

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- Close partner relations, mutual trust, contractual fidelity.

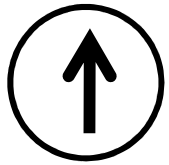
→

Exclusive Partnership

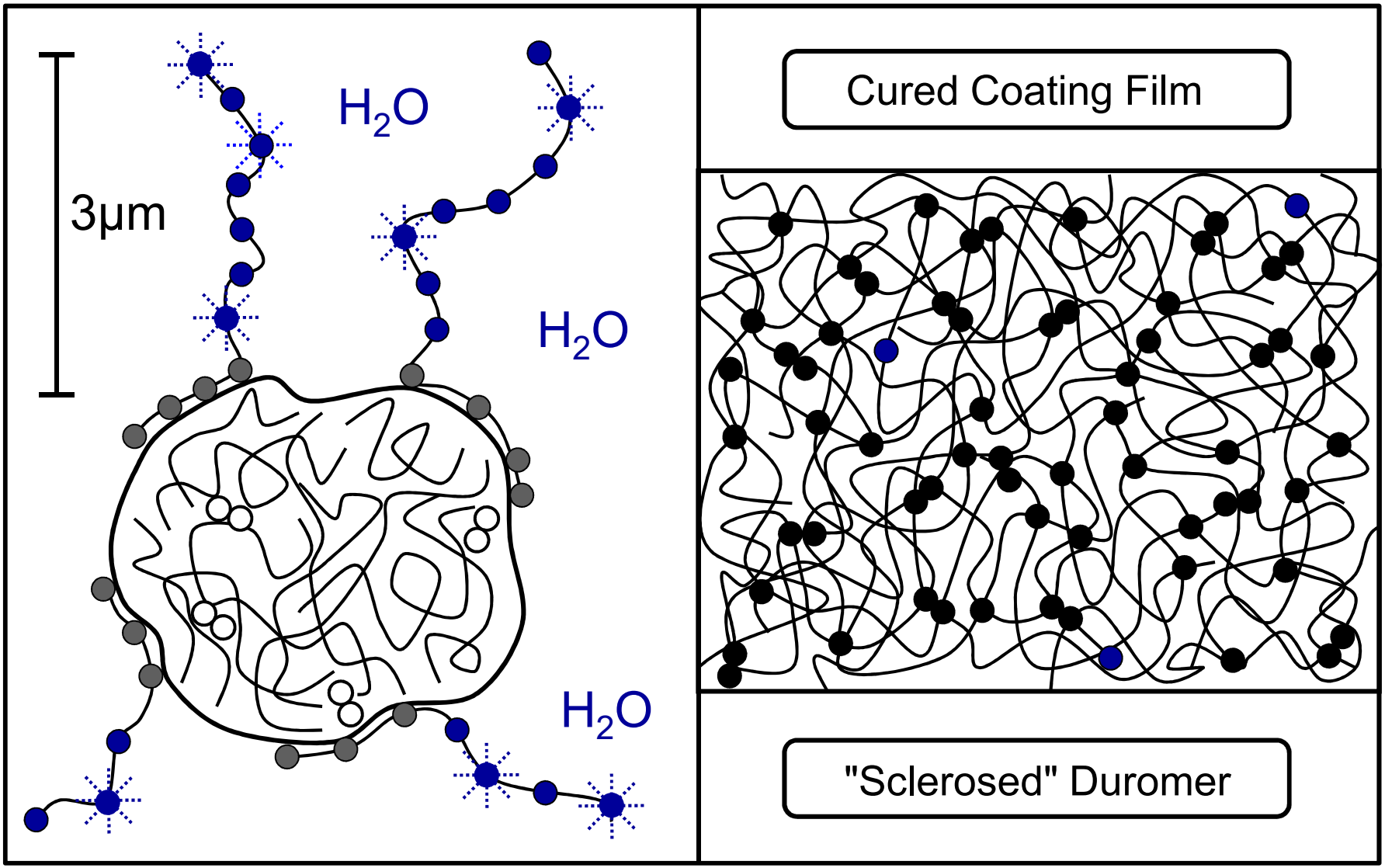
Joint R & D work in the form of a contracted joint venture. Use of the respective, highly specialized competences of both partners. Strict exclusivity!

Exclusive development of a new, completely emission-free clearcoat of the type "powder slurry" for automobiles (OEM). Contractually regulated cooperation between BASF Coatings AG, Daimler-Chrysler AG and Dürr AG (as from ~ 1994).

Targeted exchange of scientists, technicians and engineers among all partners involved.



Powder Slurry: Steric and Electrostatic Stabilisization of the Water-Suspended, Micronized Resin Particles.



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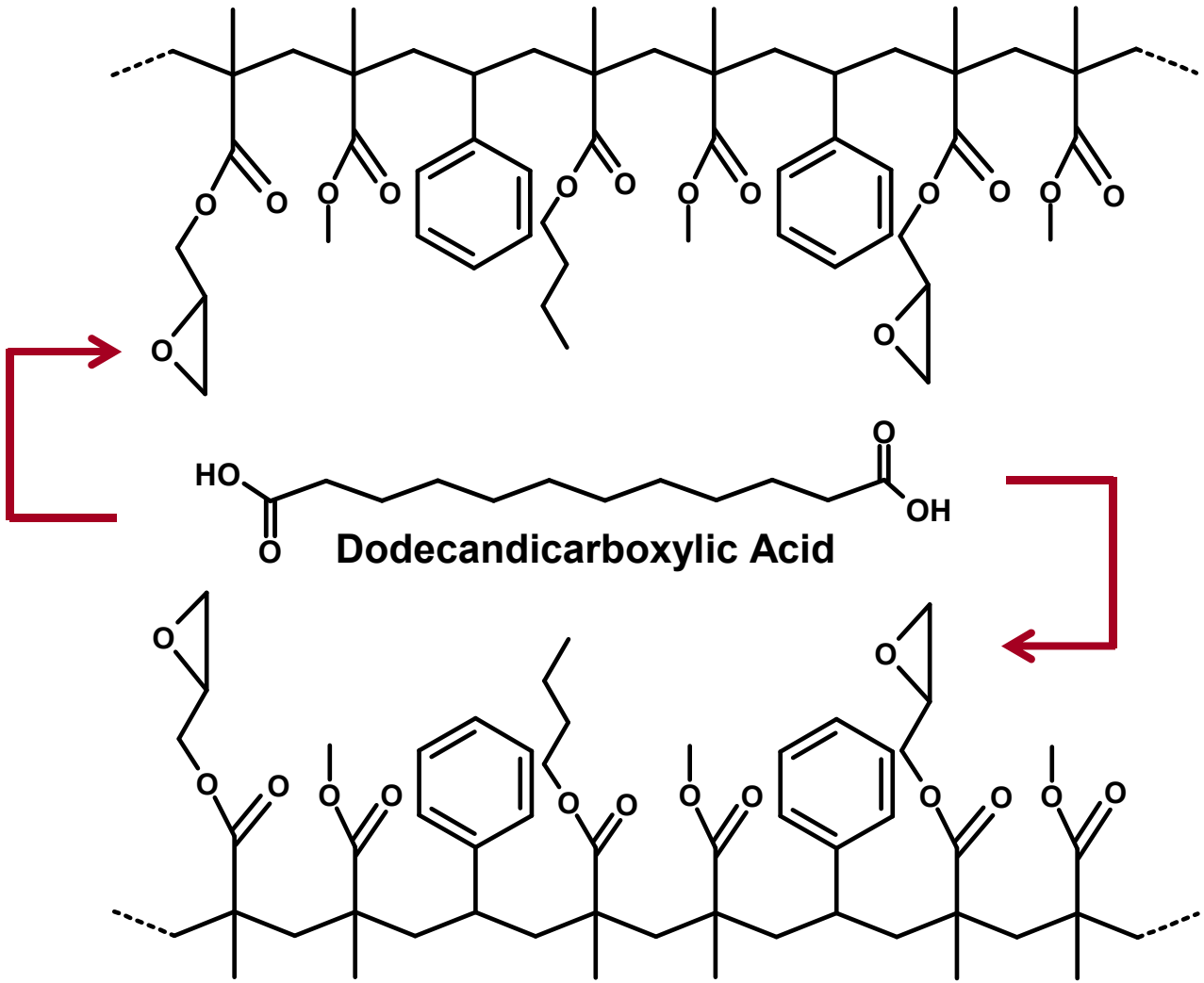
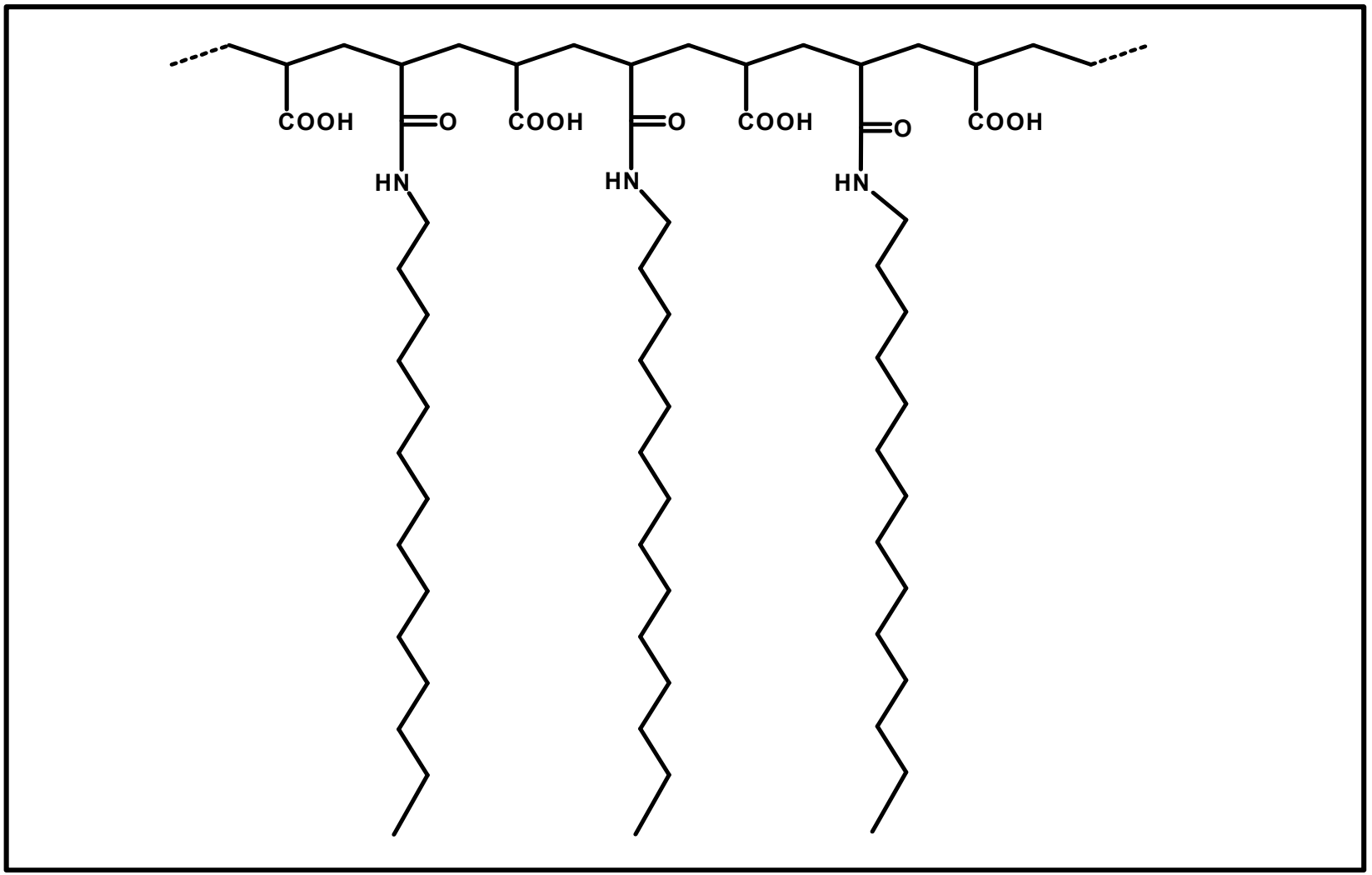
Powder Clear Coat Slurry, Automotive (OEM): Chemistry.



(Joachim Woltering et. al., BASF Coatings AG, 1994)

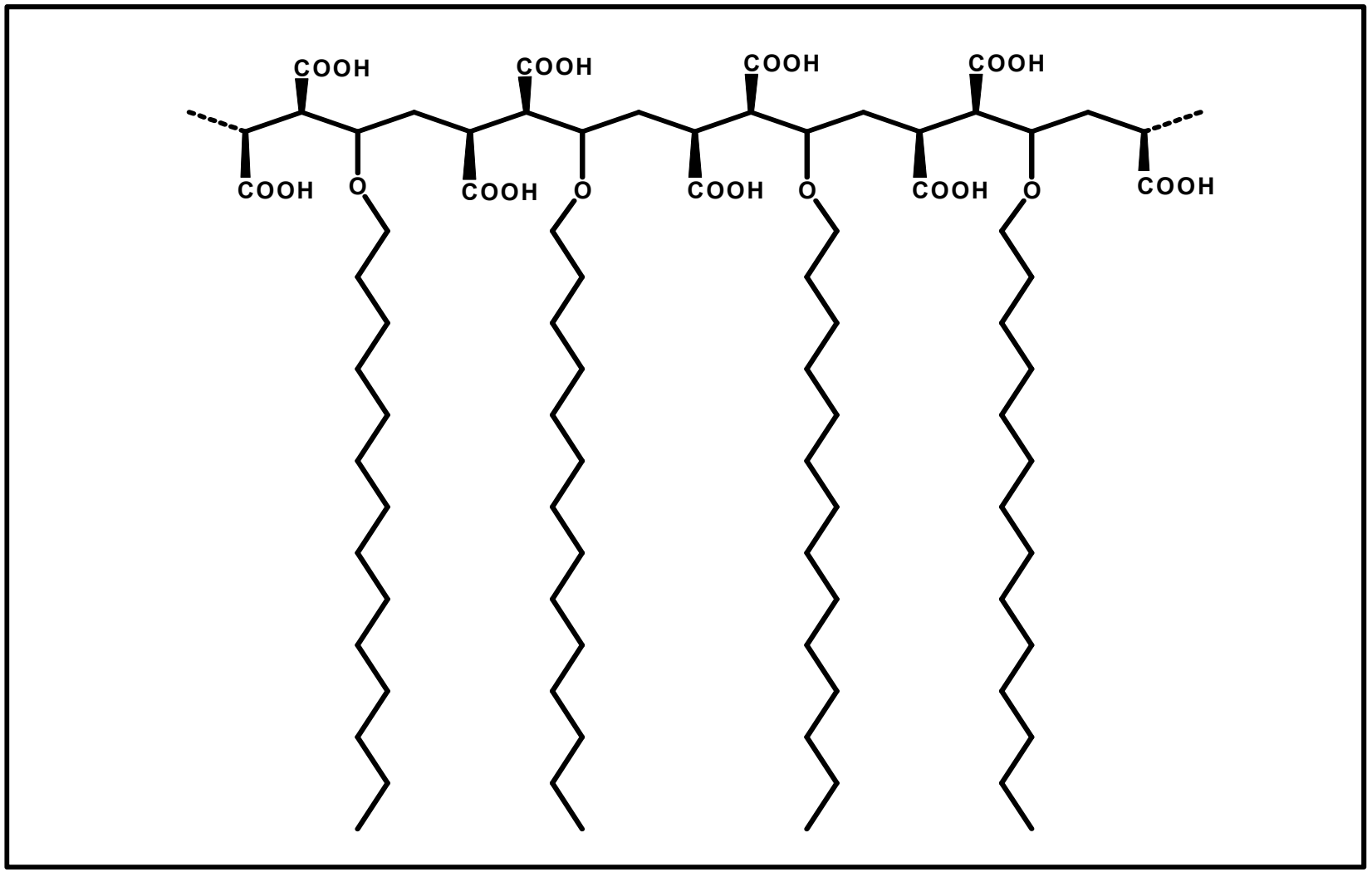
Amphiphilic, Reactive Stabilizers for the µ-Particles

Poly-N-alkyl-acrylamide (Comb Polymer Structure):



Amphiphilic, Reactive Stabilizers for the µ-Particles

Maleic Anhydride-Vinylether-Copolymer:



Exklusive Partnership with Customers

Example

BASF Coatings AG / Dürr AG / Daimler Chrysler: A new Coating System for the production of Mercedes-A-Series. A first innovative step of development *at that time* (1996).

Conventional:	**New:**
4. Clear Coat	4. Powderslurry
3. Base Coat	3. Funktional Layer 2
2. Primer Surfacer	2. Funktional Layer 1
1. E-Deposition Coat	1. E-Deposition Coat

→ Four Baking Processes or "Flash-Off-Zones".

→ Three Baking Processes or "Flash-Off-Zones".

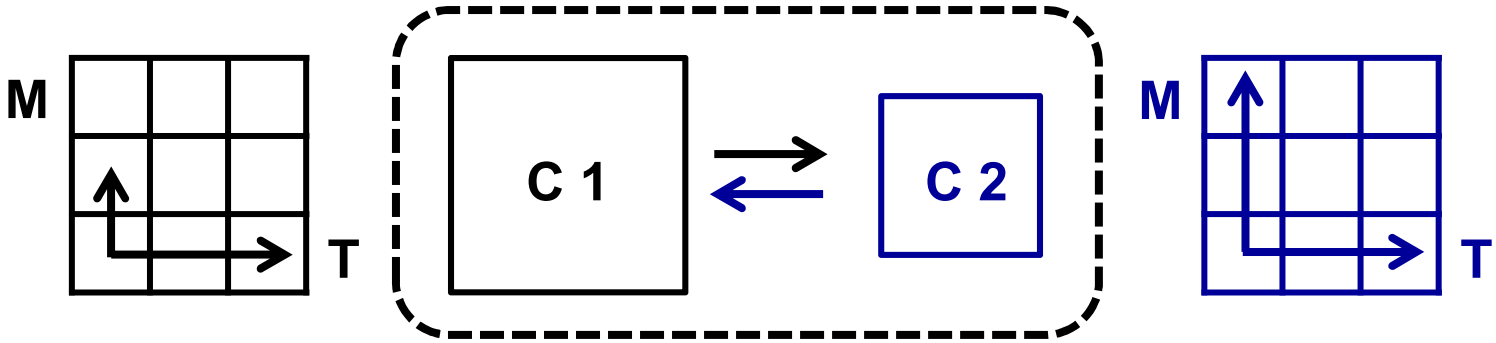
Innovations: Prerequisites for Market Success with the Process Variant explained here and its Characterization.

- Competence in the future science/technology field.
- Thorough knowledge of the business model and the new business relationships of the customer.

→

Start-Up-Partnership

Joint idea findings.
Fixation of the target system/ product design as part of the innovation project initiated with the customer.



M: Market Attractiveness

T: Technology Position

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Innovations, Process Variants.

Example

- Competence in the future science/technology field.
- Thorough knowledge of the business model and the new business relationships of the customer.

→

Start-Up-Partnership

Joint idea findings.
Fixation of the target system/ product design as part of the innovation project initiated with the customer.

Development of an X-ray or electron beam curable resist coating for an innovative small producer of silicon chips for microsystem technology equipment. Own industry experience with the development of coating systems for diverse electronic/ semiconductor components.

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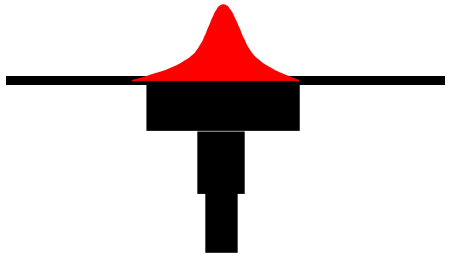
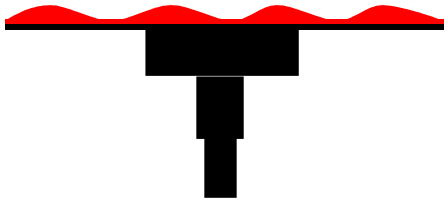
UV-Varnish, Negative Resist for the Structuring of Silicon.

Coating of the Silicon Wafer by Spin-Coating Technique:

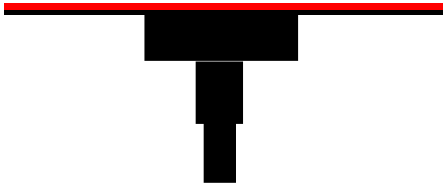
Application: 1-3 ml of the UV-curable polymer solution



Evaporation of the solvent, increase in film viscosity



Removed polymer solution: Approxi-mately 90%!



→ **Forming** for 10 seconds at 500 revolutions/min

→ **Centrifuge** for 30 seconds at 5.000 revolutions/min

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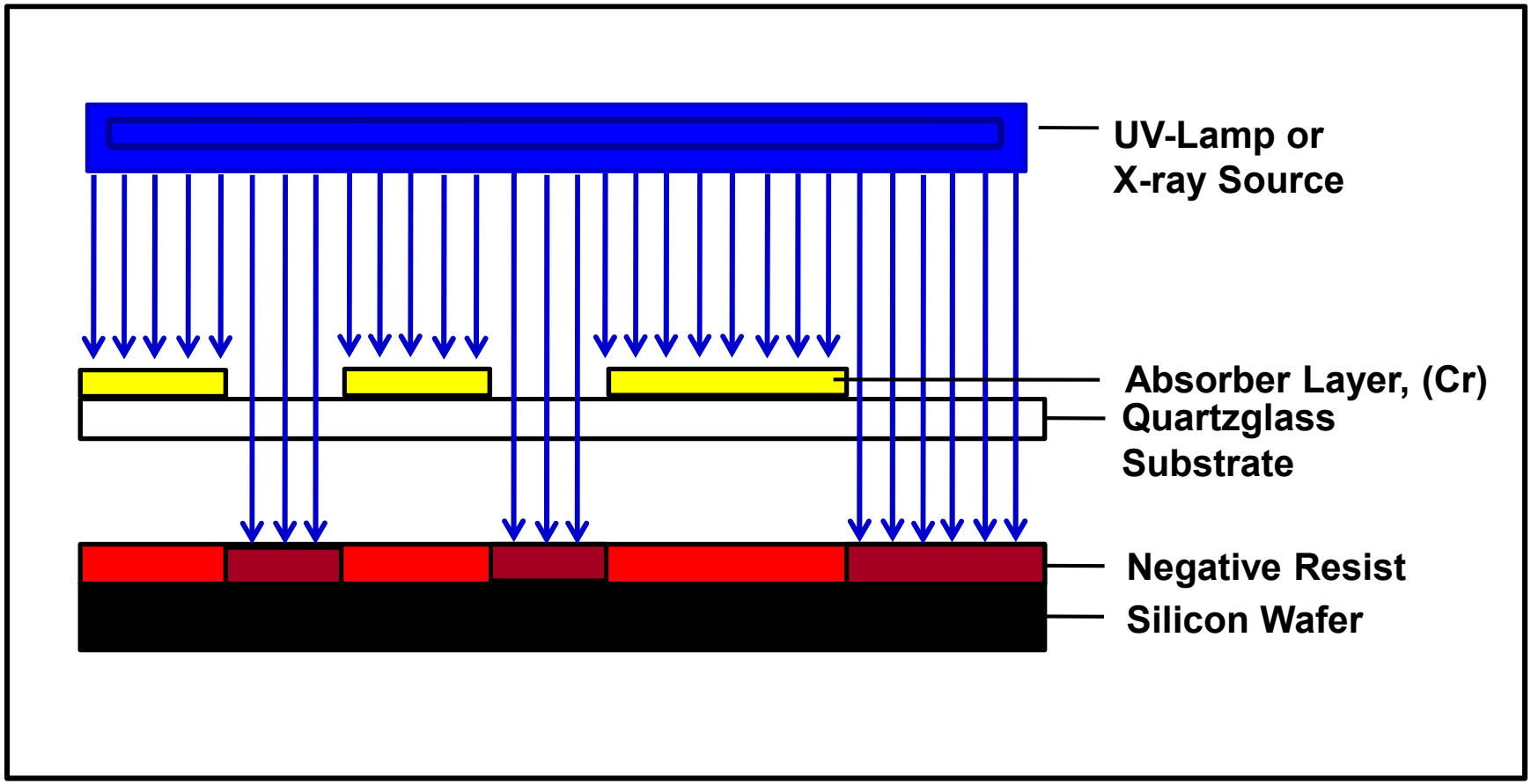
UV-Varnish, Negative Resist for the Structuring of Silicon.

Functional Principle Based on an UV Varnish:



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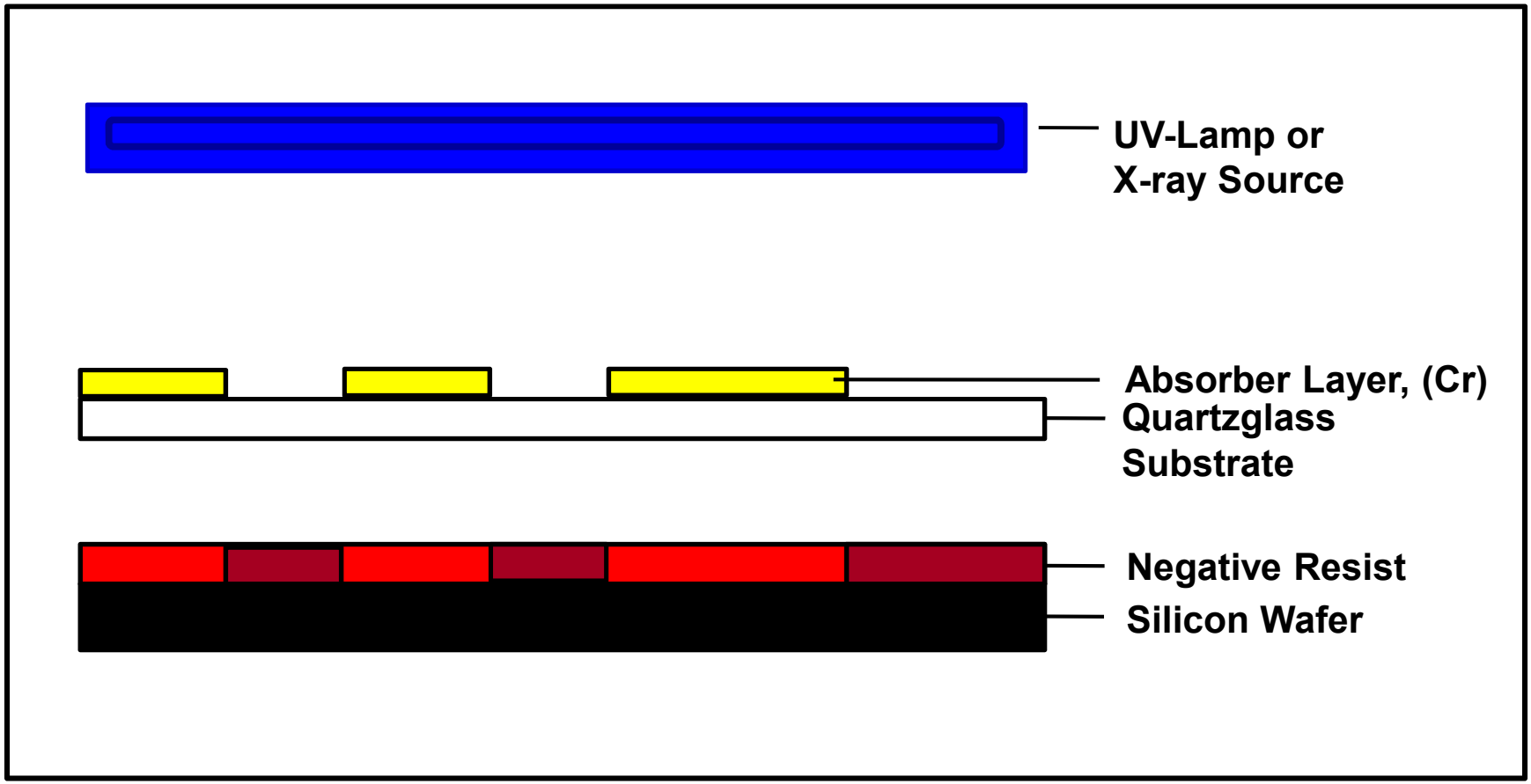
Functional Principle Based on an UV Varnish:



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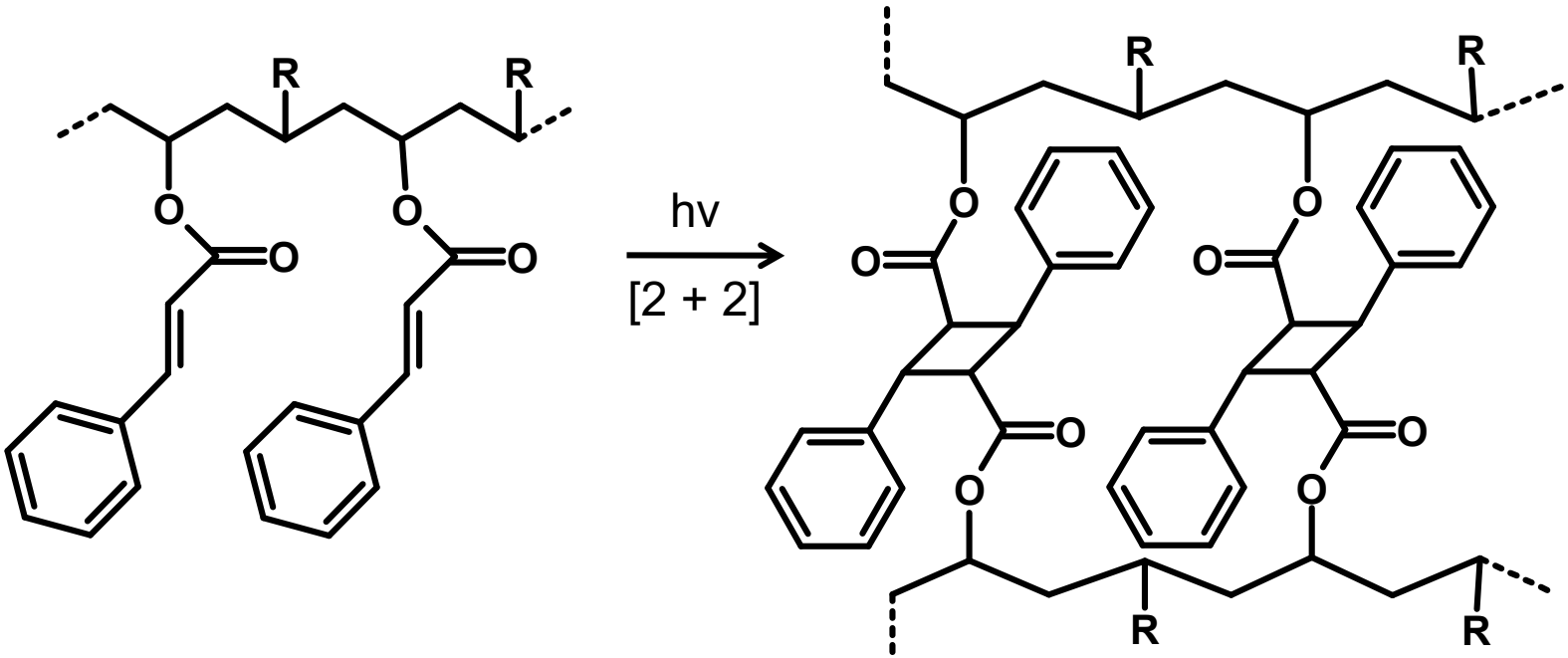
UV-Varnish, Negative Resist

UV-Curable Lacquer, Polyvinylcinnamate-Copolymer:



R = H, Alkyl, Alkoxyl

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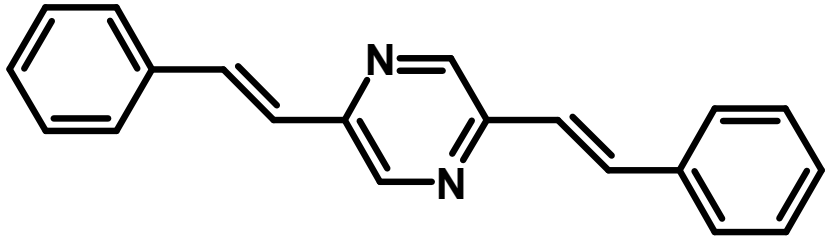
UV-Varnish, Negative Resist

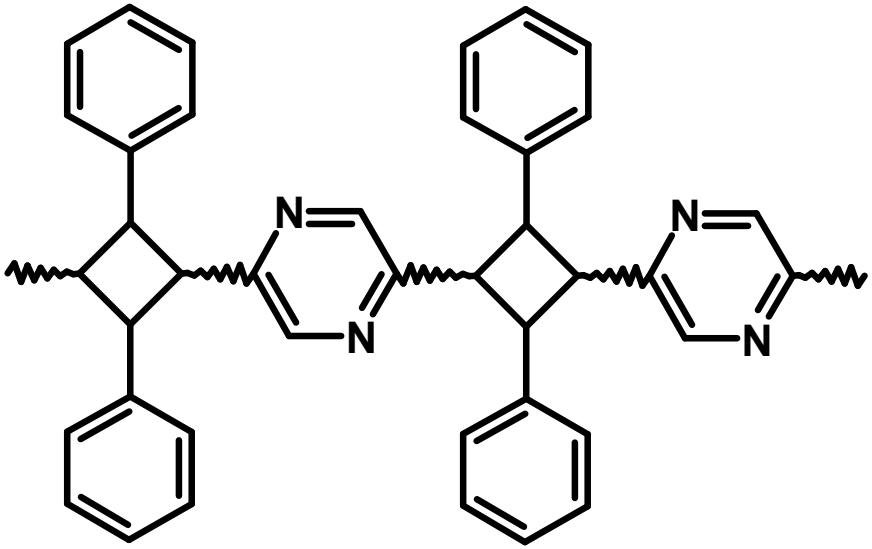
UV-Curable Lacquer, Distyrylpyrazine as Material Basis:



(Distyrylpyrazine)

hv

[2 + 2]



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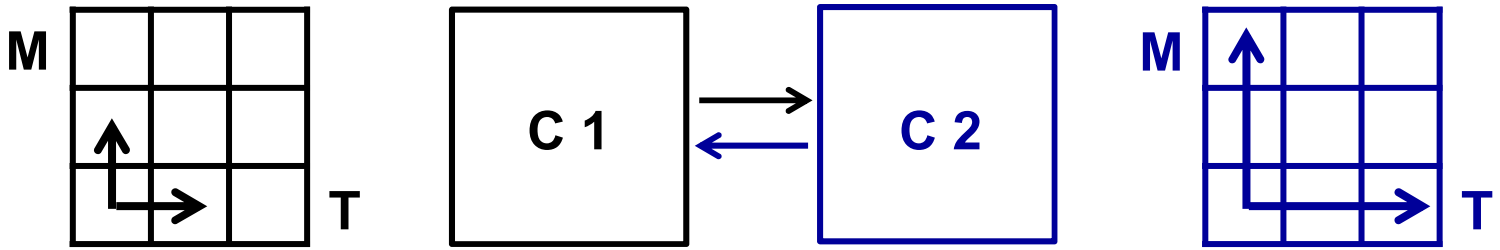
Innovations: Prerequisites for Market Success with the Process Variant explained here and its Characterization.

- Superb own idea.
- Cooperation partner with excellent expertise in the sector of the new application.

→

New Application in Market

Joint development of "pioneer applications" to market maturity, based on existing products and own, unconventional ideas.



M: Market Attractiveness

T: Technology Position

Rainer Buerstinghaus

Innovations, Process Variants.

Example

- Superb own idea.
- Cooperation partner with excellent expertise in the sector of the new application.

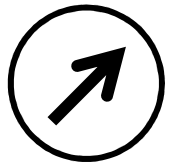
→

New Application in Market

Joint development of "pioneer applications" to market maturity, based on existing products and own, unconventional ideas.

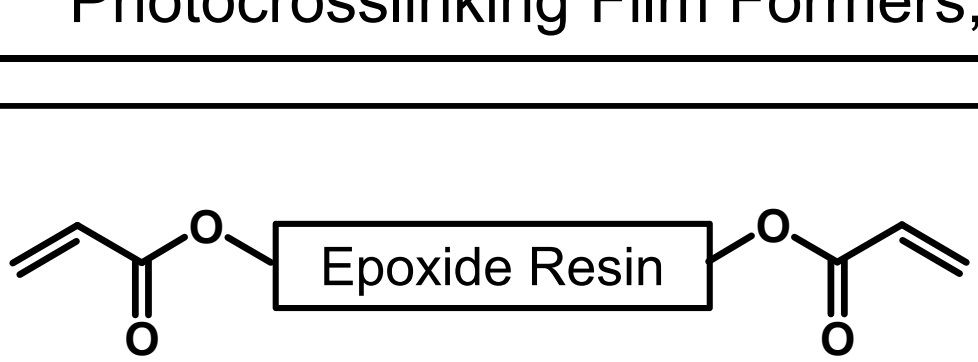
Development of a photoresist lacquer for the structuring of silicon wafers on the basis of a particle-poor, UV-curable clear lacquer, filtered in a clean room.

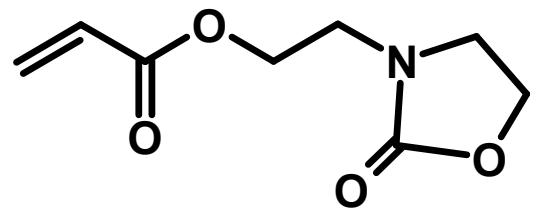
This material was previously used for coating reflectors for car headlights.



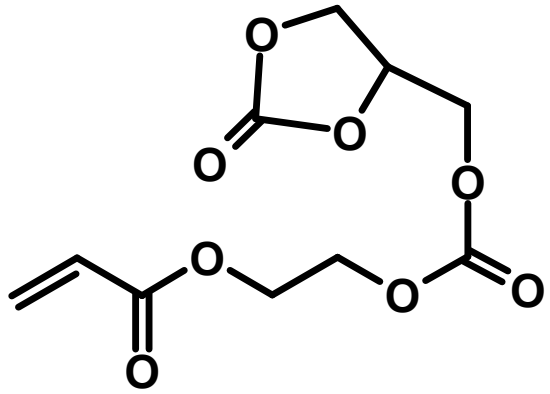
UV-Curable Varnish, Negative Resist.

Photocrosslinking Film Formers, Reactive Diluents:





Oxazolidon -
Reactive Diluent



Carbonic Acid -
Reactive Diluent

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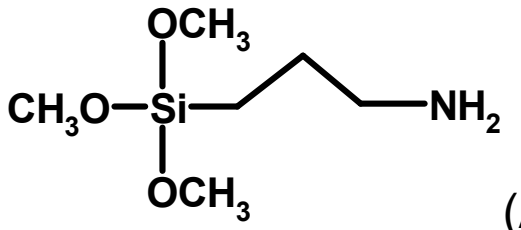
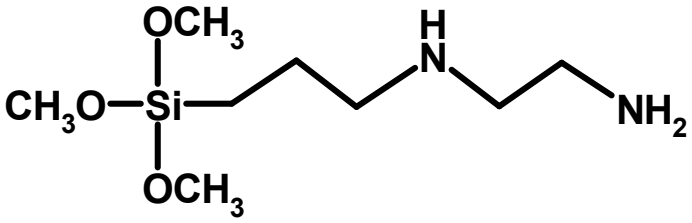
UV-Curable Varnish, Negative Resist.

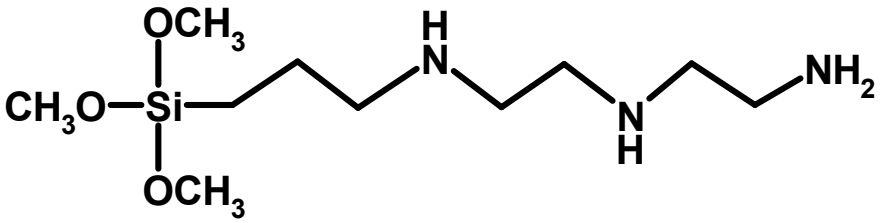
Amino Siloxanes, Adhesion Promoters for Metal-OH-Surfaces:



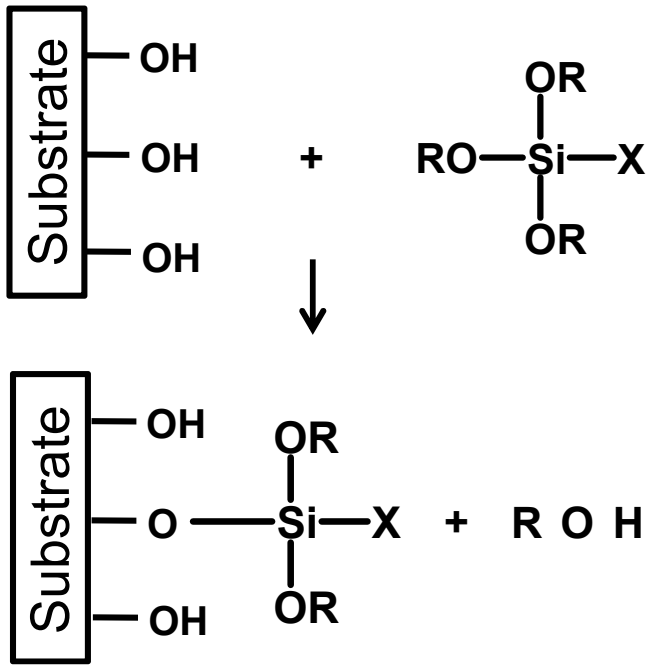
(APMS)



(Diamino-APMS)



(Triamino-APMS)



X = Organic groups with terminal NH_2 - , COOH-, NCO-functionality

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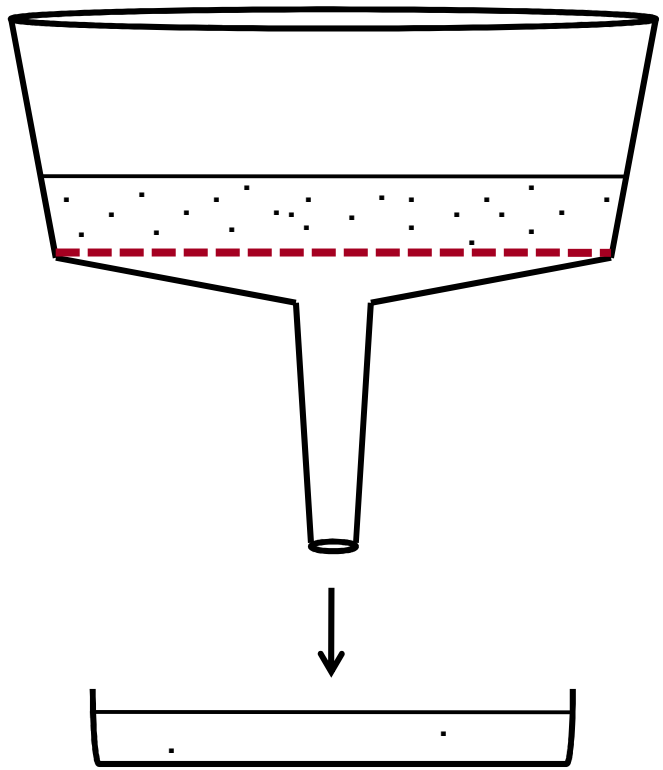
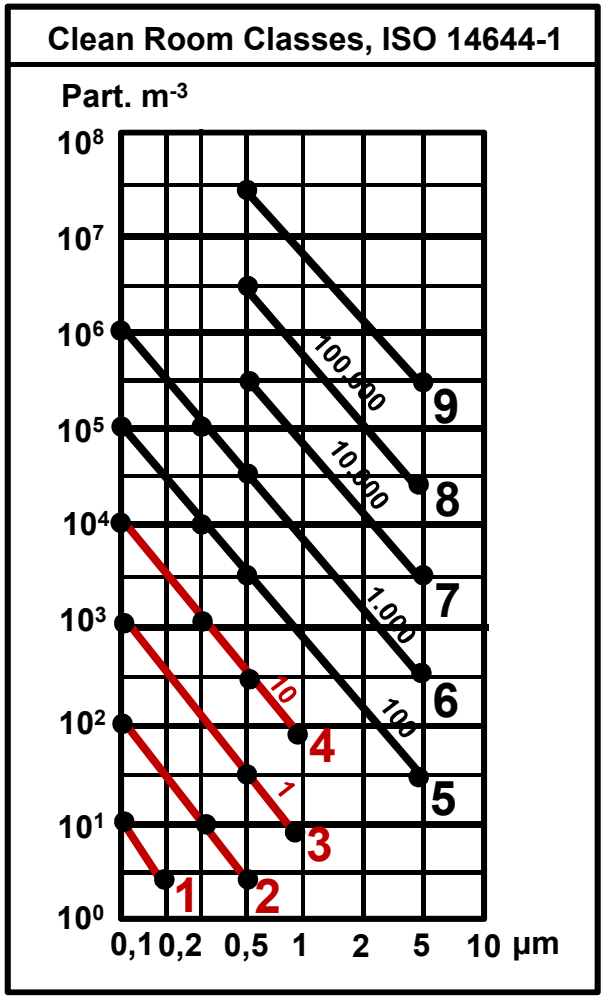
UV-Curable Varnish, Suitable for Clean Rooms 1−4 (ISO).

Filtration of Particles from the Clear Coat:



Requirement: Clean Room Class 1−4 (ISO)



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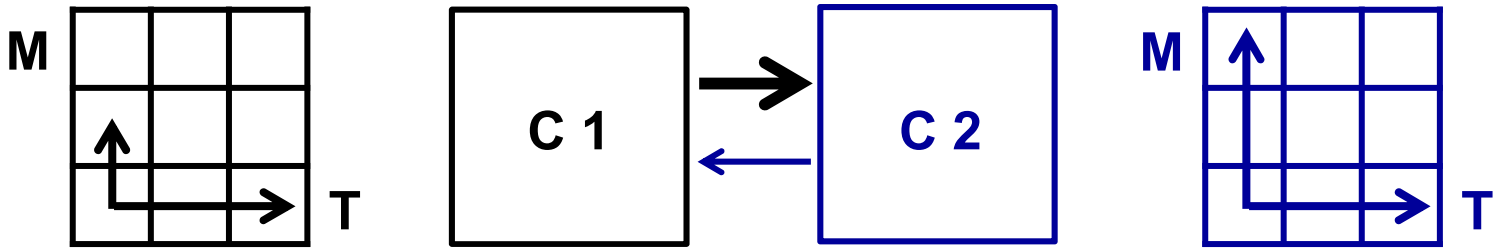
Innovations: Prerequisites for Market Success with the Process Variant explained here and its Characterization.

- Technical competence.
- Strong own patent position.
- High flexibility.
- Intensive market contacts.

→

Innovation-Steered Forward Integration

Support of small, innovative customer projects with one`s own technical and financial input, possibly also with intellectual property rights.



M: Market Attractiveness | **T**: Technology Position

Rainer Buerstinghaus

Innovations, Process Variants

Example

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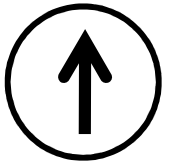
→

Innovation-Steered Forward Integration

Support of small, innovative customer projects with one`s own technical and financial input, possibly also with intellectual property rights.

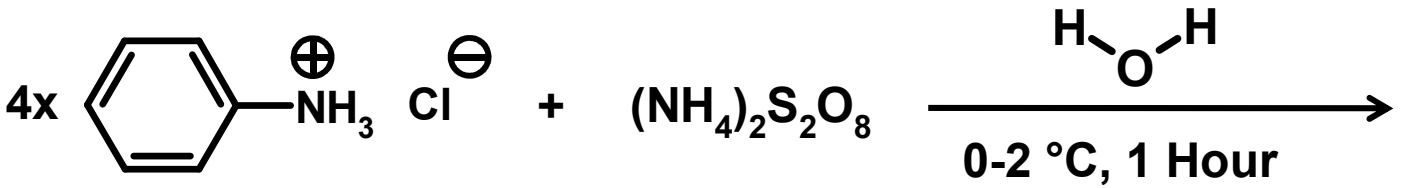
Preparation of conductive, high quality polyaniline (PANI) for the use in corrosion protection primers of metal objects.

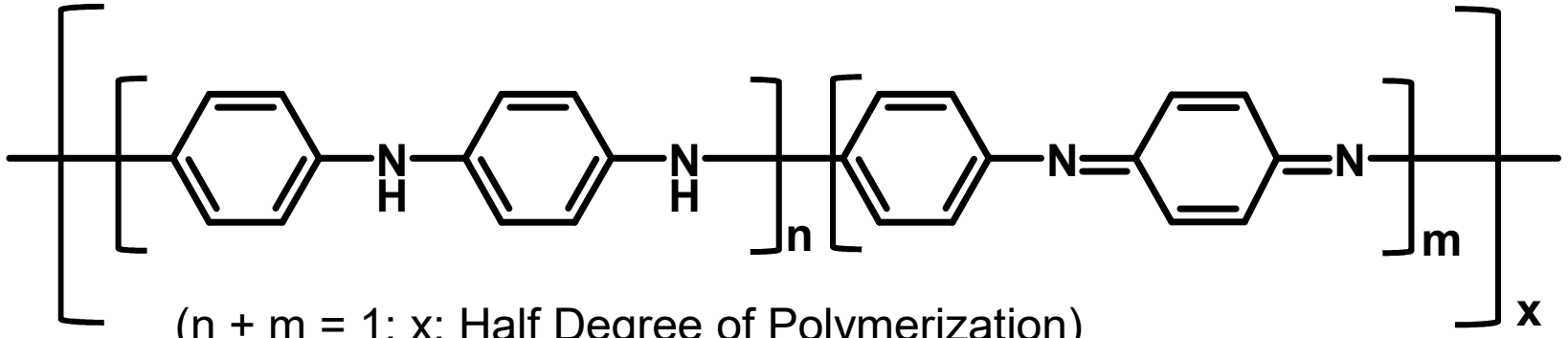
Start-up assistance for small entrepreneurs with modern testing facilities, free licenses and suitable pilot customers.



Polyaniline ("PANI"), a Polymeric Semiconductor.

Semiconducting Material with Anti-Corrosion Properties:





(n + m = 1; x: Half Degree of Polymerization)

PANI: Polyaniline (idealized structure) as a semiconducting polymer. Synthesis through oxidative polymerization of anilinium chloride with aqueous ammoniumperoxodisulfate.

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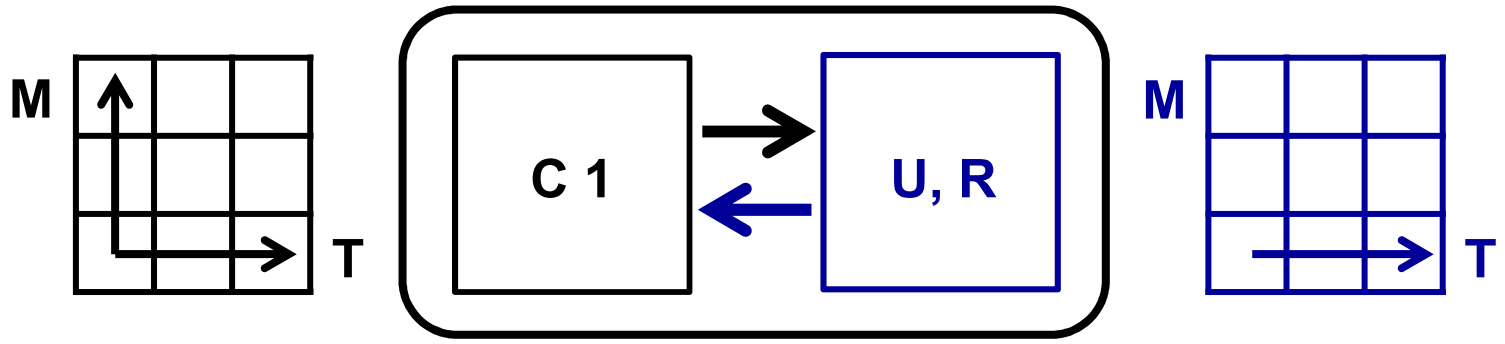
Innovations: Prerequisites for Market Success With the Process Variant Explained Here and its Characterization.

- Sound knowledge of the state of science.
- "Watertight" cooperation agreement with a clear contract of later rights of use.
- Own, active marketing, own (regulatory) toxicology.

→

Strategic Research Cooperation

Fundamental and long-term collaborative work with universities or scientific institutes. Exploration of new substances, systems, processes.



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→

Strategic Research Cooperation

Fundamental and long-term collaborative work with universities or scientific institutes. Exploration of new substances, systems, processes.

Identification, analysis and targeted conversion of natural products with specific medical or plant protective effects.

Combinatorial substance optimization, scale-up, approval procedures and market introduction.

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Innovations, Process Variants.

Example

- Sound knowledge of the state of science.
- "Watertight" cooperation agreement with a clear contract of later rights of use.
- Own, active marketing, own (regulatory) toxicology.

→

Strategic Research Cooperation

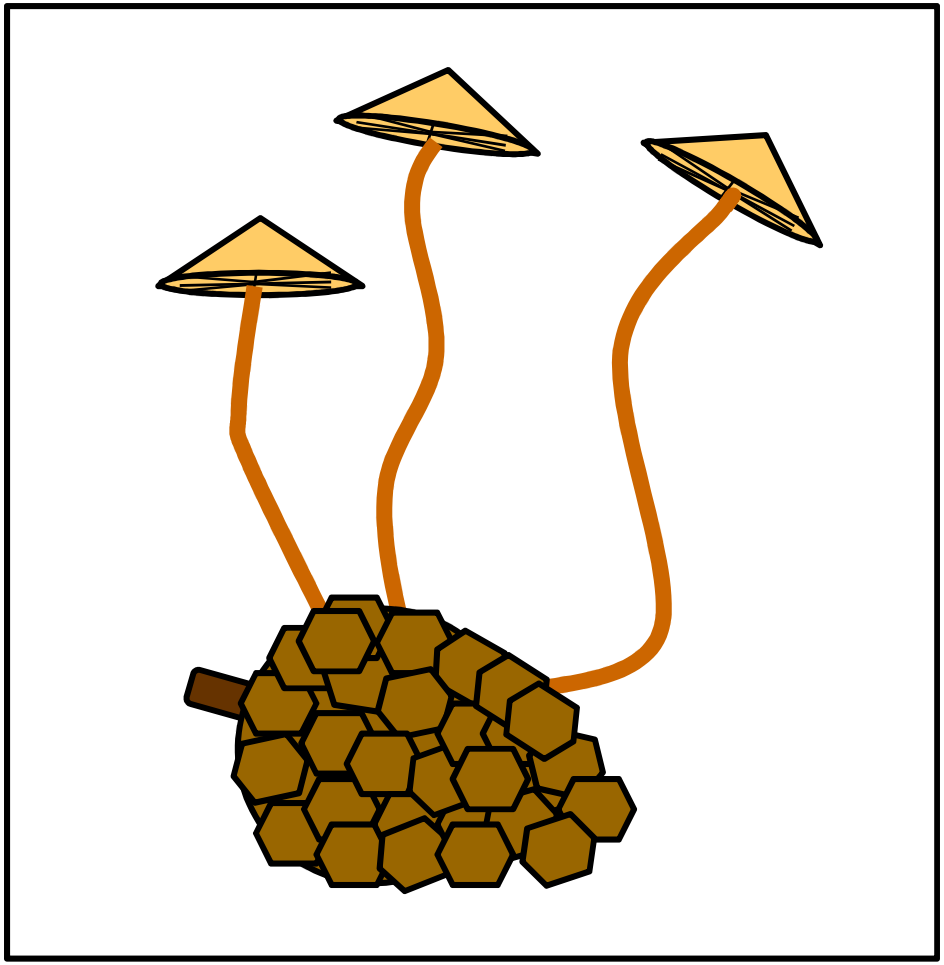
Fundamental and long-term collaborative work with universities or scientific institutes. Exploration of new substances, systems, processes.

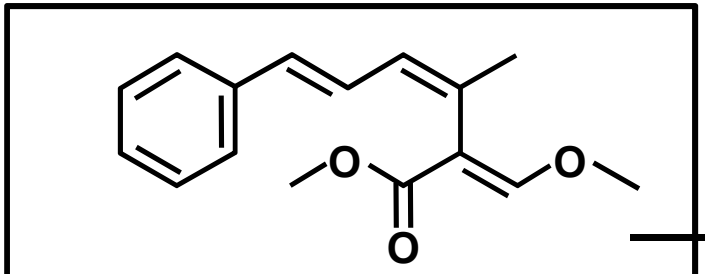
Strobilurin A ⟶ Kresoxim-methyl ("Common Name")

Cooperation partners (around 1990):
BASF Aktiengesellschaft, University of Bonn; University of Kaiserslautern
Dr. H. Sauter, Prof. Dr. W. Steglich, Prof. Dr. T. Anke

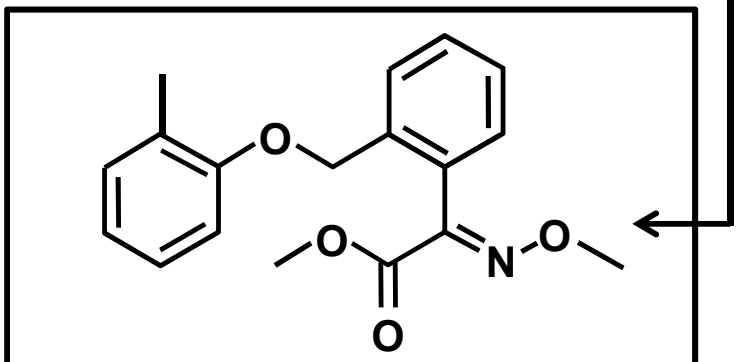
Strobilurins, a Highly Fungicidal Substance Group.

Substances, Extracted from a Fungus, Growing on Pinecones.





Strobilurin A, from
Strobilurus tenacellus



Kresoxim-methyl (1998)

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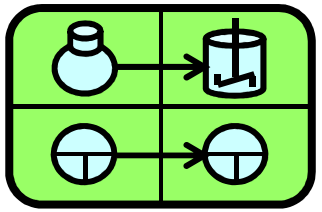

End of Lecture Module 02

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