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A Special Class Of Binders Containing Sterically Hindered Secondary Amines For High-Productivity Applications

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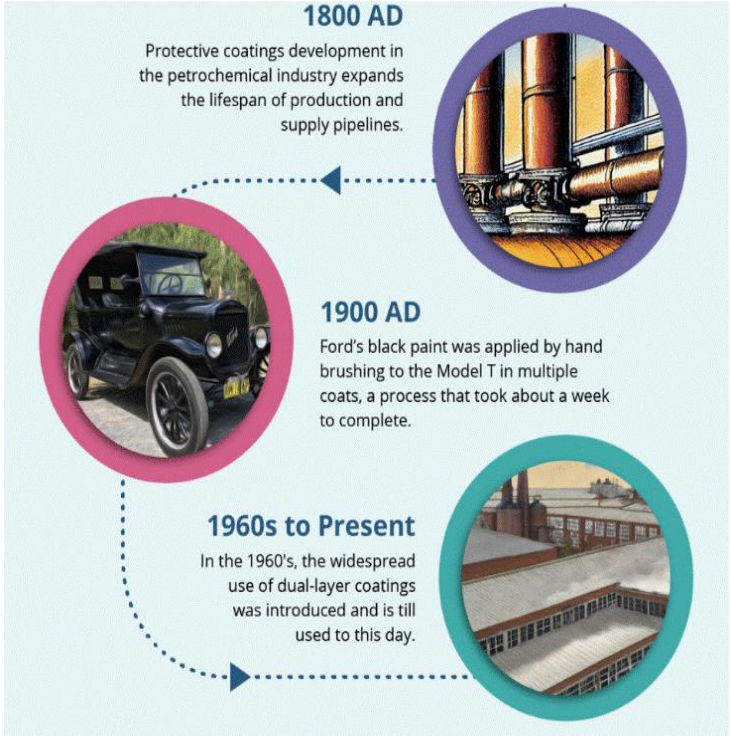
PAINTS AND COATINGS in HISTORY

One of the oldest known figurative paintings, depicting an unknown bovine, was discovered in the Lubang Jeriji Saléh cave and dated to be more than 40,000 (perhaps as old as 52,000) years old.[1,2]



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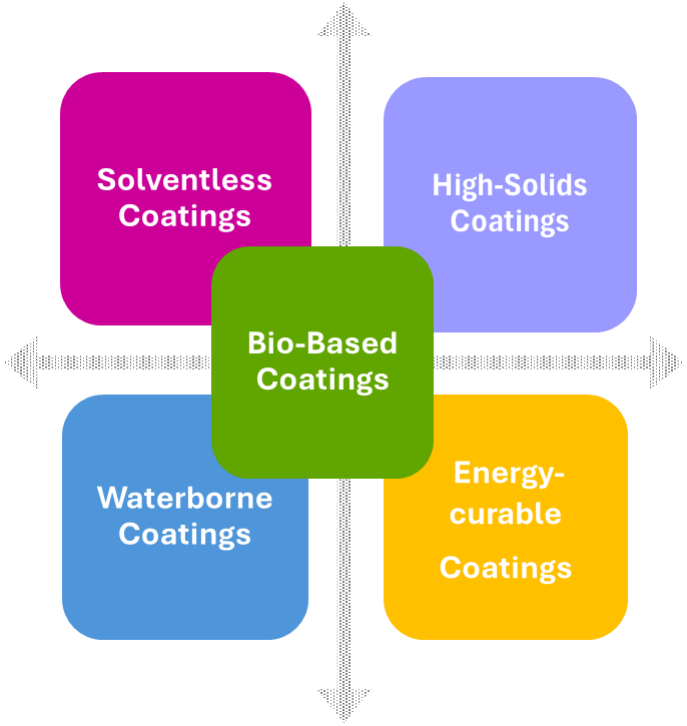
FACTORS DRIVING THE COATING TECHNOLOGY TODAY

1. Environmental and Regulatory Compliance (regulations on VOCs and HAPs, energy efficiency, recyclability)
2. Sustainability Trends (circular economy, carbon footprint)
3. Performance and Durability (corrosion resistance, wear resistance, weatherability, multi-functionality)
4. Economic Factors (cost efficiency, productivity)
5. Advanced Material Integration (smart coatings, nanotechnology)
6. Industry-Specific Demands (automotive, electronics, healthcare)
7. Digital and Automation Integration (AI, automation)
8. Consumer Preferences and Customization (Aesthetics, functional needs, health, and safety)
9. Globalization and Supply Chain Dynamics



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SOLVENTLESS LIQUID COATINGS

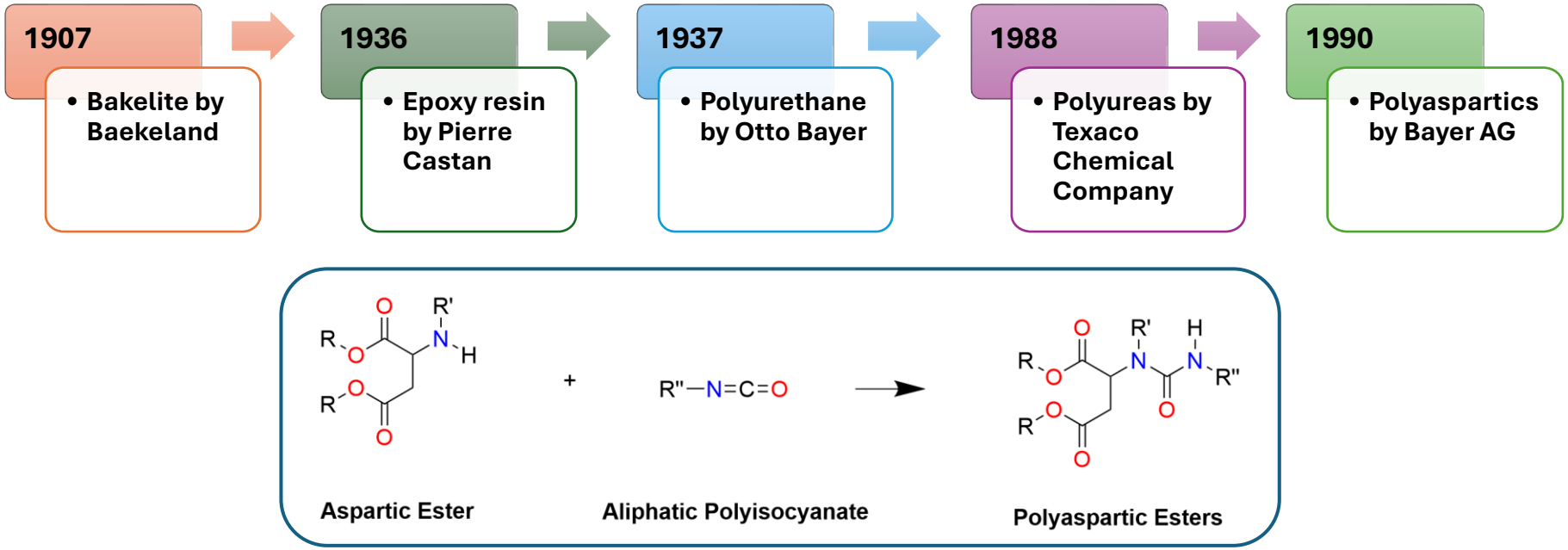
- Sustainability must transcend its role as a mere compliance measure within environmental, social, and governance frameworks if we are to confront the climate crisis meaningfully.

- **Solventless (solvent-free) coatings** are protective or decorative coatings formulated without any volatile organic solvents, so they have the advantages of being non-toxic, non-polluting, and environmentally friendly.

- Main types of solvent-free coatings:

  Epoxy → polyurethane → polyester → powder coatings → UV-curable → silicone based →polyurea → ***polyaspartics***

POLYASPARTIC ESTERS (POLYASPARTICS)-CHEMISTRY



Polyaspartic esters are solvent-free, low-viscosity substances with secondary amine groups, whose reactivity is reduced by electronic and steric effects to such an extent that they can be used to formulate highly-reactive, two-component polyurea coatings with an adequate pot life. [3,4]

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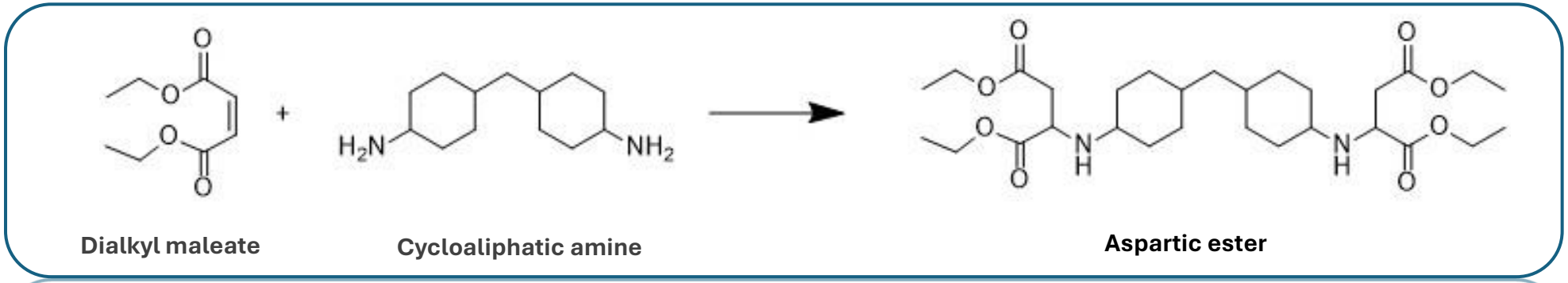
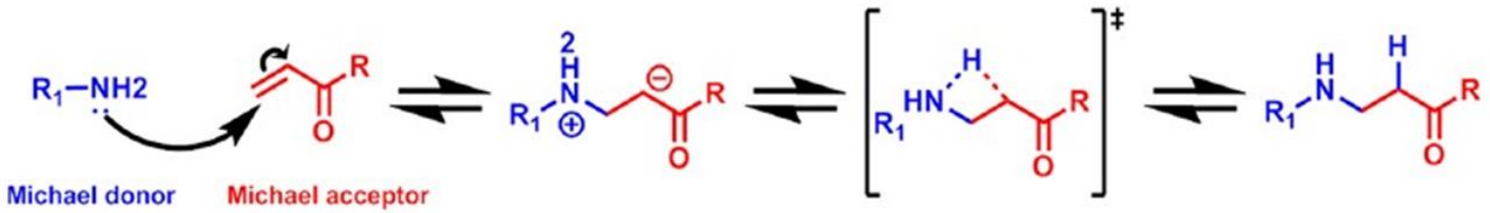
ASPARTIC ESTERS (Sterically Hindered Secondary Amines)

Aspartic esters are a special class of binders synthesized from dialkyl maleate and (cyclo)aliphatic amines via aza-Michael addition reaction, which contains more or less sterically hindered secondary amines. These solvent-free crosslinking reagents can be employed for the formulation of fast-curing 2K PU coatings, even at room temperature.

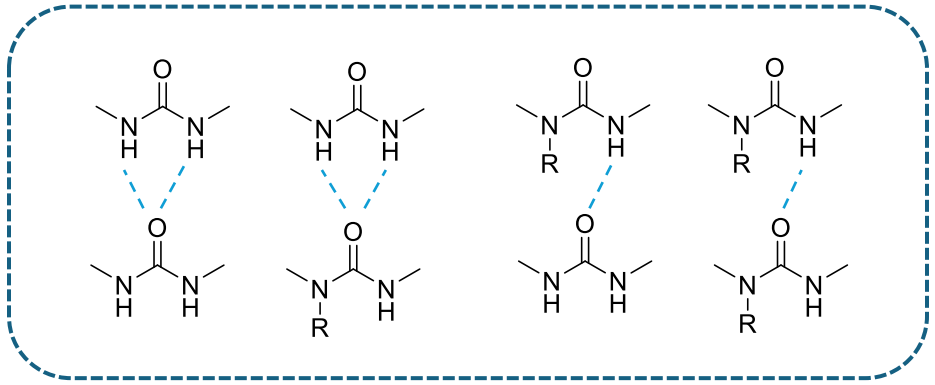




Aza-Michael addition rxn

POLYASPARTIC ESTERS (POLYASPARTICS)-CHEMISTRY

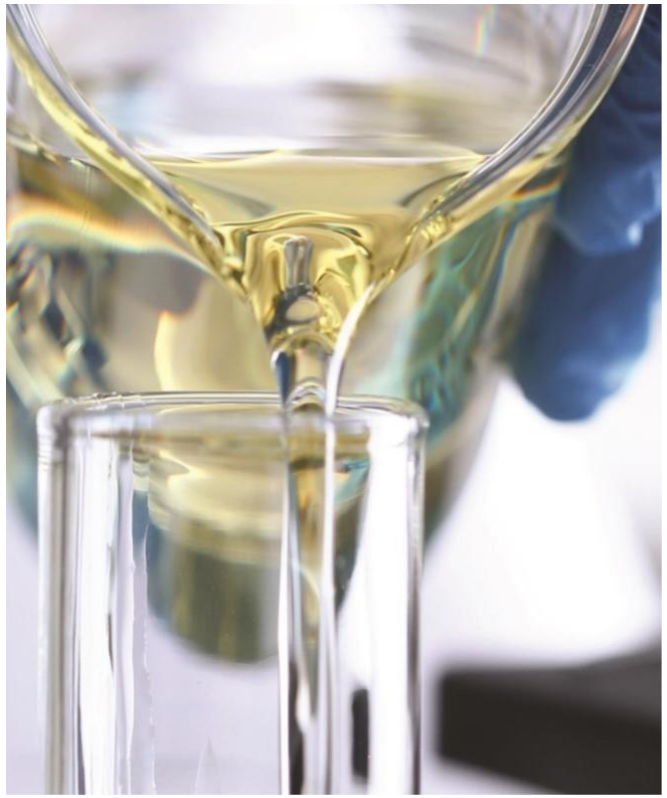
Amine-functional binders play a crucial role in forming supramolecular systems through hydrogen bonding between urea groups. This interaction significantly enhances the mechanical strength and performance of the coating. The system self-assembles via these hydrogen bonds, and the overall strength of the coating increases with a higher concentration of bidentate moieties.[5]



Intramolecular hydrogen bonding between carbonyl and amino groups in polyaspartic esters lowers viscosity and extends pot life. Humidity disrupts this bond, releasing reactive hydrogen atoms that can react with isocyanates. Unlike other amine-functional polymers, polyaspartic esters offer longer pot life in dry conditions due to this internal stabilization.

SOME FACTS ABOUT POLYASPARTIC COATINGS

- They are 100% solids, low viscosity, secondary amine resins
- They have variable cure times from minutes to hours.
- The reactivity /working time depends on the selection of the polyisocyanate.
- By varying the ratio of the aliphatic polyisocyanates and polyaspartic resins, the mechanical properties of the coating system can be fine-tuned.
- A higher water content in the resin accelerates the reaction→working time is shorter.
- Humidity affects the curing time (walk-on time) but does not impact the working time.
- CO_2 (water + polyisocyanate) formation has no chance of forming bubbles in the coating due to the fast curing time.



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GLOBAL POLYASPARTIC COATINGS MARKET

	2024	CAGR (from 2024 to 2031)
Global Polyaspartic Coatings Market Sales Revenue	**$ 354.2 Million**	**5%**
North America Polyaspartic Coatings Market Sales Revenue	**$ 141.68 Million**	**3.2%**
Mexico Polyaspartic Coatings Market Sales Revenue	$ 12.89 Million	3.7%
Canada Polyaspartic Coatings Market Sales Revenue	$ 17 Million	4%
United States Polyaspartic Coatings Market Sales Revenue	$ 111.79 Million	3%
Europe Polyaspartic Coatings Market Sales Revenue	**$ 106.26 Million**	**3.5%**
France Polyaspartic Coatings Market Sales Revenue	$ 9.78 Million	2.7%
Spain Polyaspartic Coatings Market Sales Revenue	$ 8.71 Million	2.6%
United Kingdom Polyaspartic Coatings Market Sales Revenue	$ 17.85 Million	4.3%
Russia Polyaspartic Coatings Market Sales Revenue	$ 16.47 Million	2.5%
Italy Polyaspartic Coatings Market Sales Revenue	$ 9.14 Million	2.9%
Germany Polyaspartic Coatings Market Sales Revenue	$ 21.04 Million	3.7%
Rest of Europe Polyaspartic Coatings Market Sales Revenue	$ 16.47 Million	2.2%
Asia Pacific Polyaspartic Coatings Market Sales Revenue	**$ 81.47 Million**	**7%**
Korea Polyaspartic Coatings Market Sales Revenue	$ 8.15 Million	6.1%
Japan Polyaspartic Coatings Market Sales Revenue	$ 11.24 Million	5.5%
China Polyaspartic Coatings Market Sales Revenue	$ 36.66 Million	6.5%
Australia Polyaspartic Coatings Market Sales Revenue	$ 4.24 Million	6.7%
India Polyaspartic Coatings Market Sales Revenue	$ 9.78 Million	8.8%
Rest of APAC Polyaspartic Coatings Market Sales Revenue	$ 5.78 Million	6.8%
South America Polyaspartic Coatings Market Sales Revenue	**$ 17.71 Million**	**4.4%**
Colombia Polyaspartic Coatings Market Sales Revenue	$ 1.58 Million	4.2%
Argentina Polyaspartic Coatings Market Sales Revenue	$ 2.98 Million	5.3%
Brazil Polyaspartic Coatings Market Sales Revenue	$ 7.58 Million	5%
Chile Polyaspartic Coatings Market Sales Revenue	$ 1.28 Million	4.7%
Peru Polyaspartic Coatings Market Sales Revenue	$ 1.45 Million	4.6%
Rest of South America Polyaspartic Coatings Market Sales Revenue	$ 2.85 Million	3.5%
Middle East Polyaspartic Coatings Market Sales Revenue	**$ 7.08 Million**	**4.7%**
Turkey Polyaspartic Coatings Market Sales Revenue	$ 0.61 Million	4.2%
Egypt Polyaspartic Coatings Market Sales Revenue	$ 0.74 Million	5%
Rest of MEA Polyaspartic Coatings Market Sales Revenue	$ 0.84 Million	3.7%

Market Dynamics:[6]

- Global top five manufacturers hold a share of over 86%.
- In terms of application, the largest application is building and construction, with a share of over 40%.
- Wind Turbine Blade Coating is the fastest-growing application segment, projected to grow at a CAGR of 10% due to the expansion of renewable energy infrastructure worldwide
- Key drivers:

i. Growing demand for eco-friendly and high-performance materials

ii. Technological advancements in resin formulations

iii. Expanding use of polyaspartic coatings in automotive, infrastructure and renewable energy sectors.

- High initial costs are the restraining factor.

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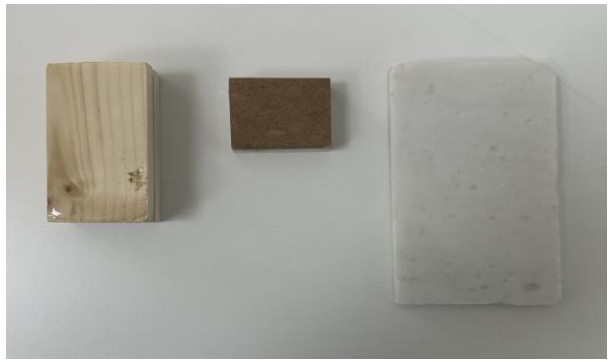
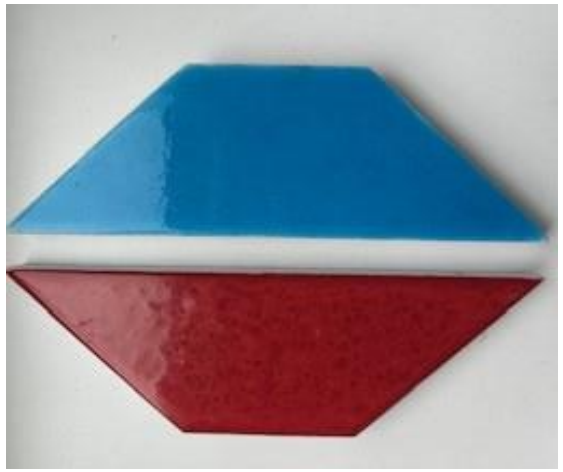
ADVANTAGES OF POLYASPARTIC COATINGS

- Chemical resistance
- Good mechanical properties
- Flexibility
- Adhesion
- UV stability
- Robust and easy application
- Rapid curing
- Weatherability
- Low VOC
- Low-temperature application
- Barrier protection
- Additive compatibility
- High film build





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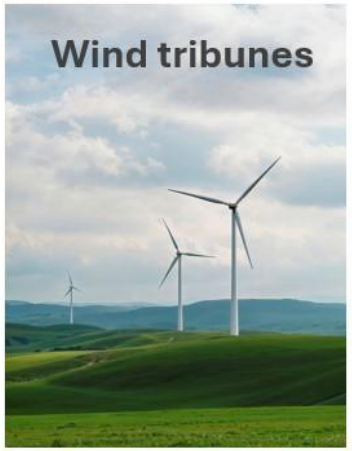
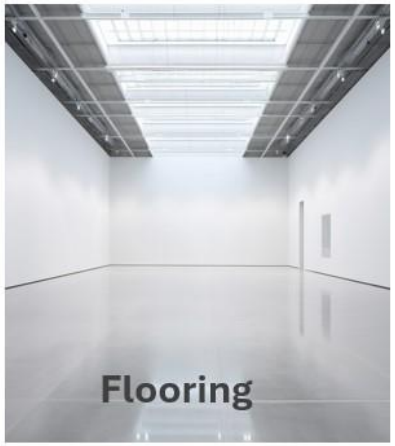
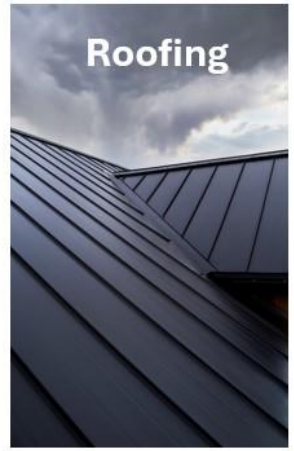
COMPARISON OF COATING TECHNOLOGIES

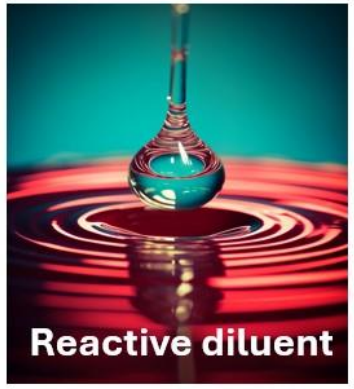
Feature	Polyaspartic	Epoxy	Polyurethane	Polyurea
Abrasion Resistance	**Excellent:** withstands high-wear, traffic and impacts	**Very Good:** strong abrasion resistance but may scratch or wear faster in high traffic zones	**Good:** Softer than epoxy but flexible, making it better in dynamic environments. Protective as a topcoat	**Excellent:** Highly abrasion resistant; great for heavy-duty use and tear
Adhesion	**Excellent:** bonds tightly to concrete and other coatings. Penetrate well into substrate pores.	**Excellent:** creates stong mechanical and chemical bond, needs well prepared surfaces	**Good:** typically used as a topcoat, adheres well to cured epoxy/primer layers	**Excellent:** bonds aggresively even to damp or green concrete, high cohesive strength
Application Method	**Roller, squeeegee or airless sprayer:** fast cure requires trained applicators and precise mixing	**Roller or notched squeegee with spike rollers:** managable for experienced DIYers	**Roll or spray**: easier than epoxy in some cases	**Spray:** needs special equipment and skill. Rapid set time makes it tricky
Application Temperature	**-10 °C to 35 °C:** cures even in colder environments	**10 °C to 30 °C:** sensitive to both low temperatures and high humidity	**10 °C to 35 °C:** slow to cure in cold, may bubble in high humidity	**-20 °C to 60 °C:** widest range; unaffected by sub-zero or high-heat conditions
Best Applications	High-traffic garages, warehouse, outdoor deck's, showrooms, cold climate regions	Basements, indoor garages, production areas, airplane hangars	Topcoat for epoxy floors, amps, decks, areas with chemical exposure	Chemical plants, food facilities, parking decks, cold storage, tank linings
Chemical Resistance	**Excellent:** resist oils, gasoline, de-icing salts, cleaners and acids	**Good to excellent:** may discolor but won't deteriorate from many acids, alkalis, solvents	**Excellent:** strong resistance to oils, fuels, harsh detergents	**Outstanding:** handles acids, solvents, and industrial chemicals continuously
Cost	**High:** premium material	**Moderate**: widely available and cost effective	**Moderate to high:** depends on formulation	**High:** expensive due to application method
Cure Time	**Very fast:** touch dry in 1-2 hrs, full cure ~24 hrs	**Slow:** touch dry in 8-12 hrs, full cure 3-7 days	**Moderate:** touch dry in 4-8 hrs, full cure 1-2 days	**Instant:** touch dry in 1-2 hrs, full cure<24 hrs
Durability	**Excellent:** highly durable and long-lasting,retains gloss, strength under heavy use, UV and weather	**Very Good:** tough but can yellow under UV and chalks outdoors	**Very Good:** good elasticity and UV stability (aliphatic PU), very durable as a protecive layer	**Excellent:** durable against chemicals, impact, abrasion and wear
Flexibility	Highly flexible and resistant to impact and abrasion. It won't crack under thermal expansion	Relatively rigid and brittle once cured. Prone to cracking under movement	More flexible than epoxy-it can withstand some movement making it a good topcoat option	Exceptionally flexible with elongation properties. Ideal for environments with heavy thermal cycling or substrate movement.
Gloss/Finish	**High-gloss, satin and matte available:** retains finish.	**High gloss:** shiny and clean finish, customizable	**Glossy to satin:** maintains clarity	**Glossy:** matte achievable with texture or flake
Installation Difficulty	**Moderate to high:** rapid cure limits workings time	**Modearte:** forgiving pot life, but prep-intensive	**Moderate:** sensitive to environment	**High:** specialized aquipment and training needed
Life Span	**10–20 years:** very long-lasting	**5–10 years:** long but prone to yellowing	**7–12 years:** decent lifespan	**15–25 years:** extremely long-lasting
Moisture Tolerance	**High:** tolerates slightly damp surfaces	**Low:** requires bone-dry surface, prone to blistering	**Moderate:** moisture can cause bubbling or curing issues	**Very high:** even tolerates moist or green concrete
Pot Life	**20–30 mins:** short working window	**30–60 mins:** workable time before it hardens	**30–45 mins:** more forgiving	**Seconds:** must work extremely fast
Slip Resistance	**Moderate to high** (with additives)	**Moderate to high** (with grit additives)	**Moderate:** depends on surface; needs additives to enhance traction	**Moderate**: can be textured
Thickness	50-150 µm	100-300 µm (high build options)	50-200 µm	500-2000 µm (spray-applied thick films)
UV Resistance	**Excellent:** does not yellow or degrade, ideal for outdoor applications	**Poor:** tends to yellow and chalk under sunlight	**Good:** resists yellowing, often used as topcoat	**Excellent:** highly UV resistant, remains colorfast for years
VOC& Odor	**Low or no VOC-Odor:** newer formulas are eco-friendlier.	**Moderate to high VOC-strong odor:** needs ventilation	**Moderate to high VOC depends on formulation):** resspirators required	**Low VOC:** newer versions are green-crtified

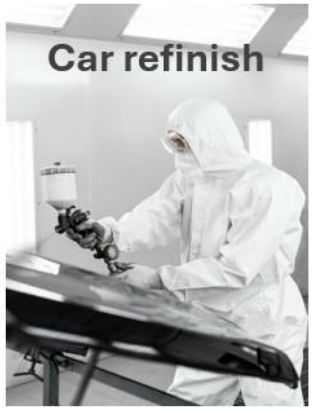
APPLICATION AREAS











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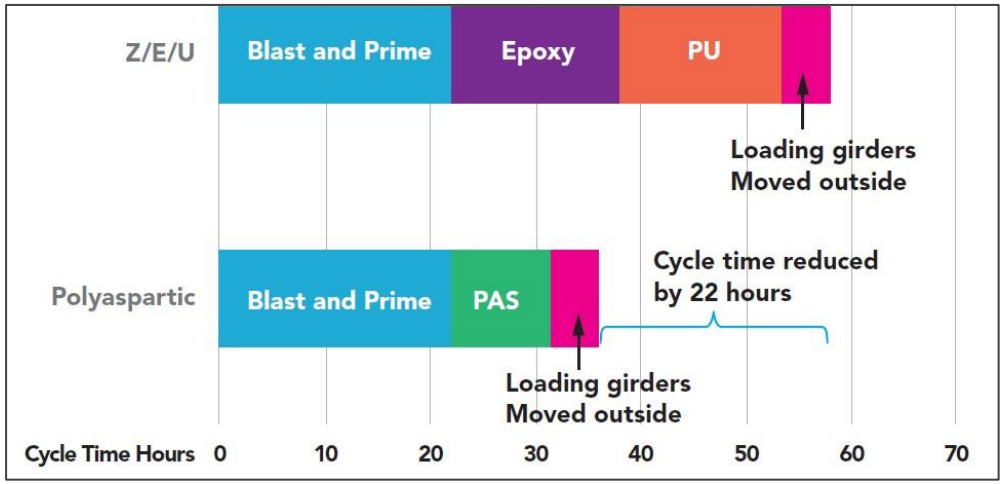
CASE STUDY

Main Bridge in Stockholm:

The polyaspartic coating system reduced painting operation costs by 28%, leading to an overall 14% painting cost reduction and a 2% decrease in the total cost of the fabricated and painted steel girders, even after accounting for raw material cost increases. [7]



POT-LIFE and FILM FORMATION TIME

PAE	Polyisocyanate	Pot-Life	Drying Time	Property
PAE-1	HDT-LV2	17 min	18 min	Hard surface
PAE-2	HDT-LV2	7h 10 min	9-24h	Hard surface
PAE-3	HDT-LV2	1h 50 min	5h	Soft surface

Product	Solid content, %	Equivalent Weight	Viscosity (25 °C, mPa.s)
PAE-1	100	276	800-1800
PAE-2	100	291	600-1800
PAE-3	100	295	<500

PAE = Polyaspartic Ester
HDT-LV2 = a solvent-free low low-viscosity aliphatic polyisocyanate

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POT-LIFE and FILM FORMATION TIME

HDT-LV2 = a solvent-free low low-viscosity aliphatic polyisocyanate

XFLO100 = partially bio-based, solvent-free free and low viscosity aliphatic isocyanate polymer.

PAE	Polyisocyanate	Pot-Life	Drying Time
PAE-1:PAE-2 (80:20%)	HDT LV2: XFLO100 (50:50%)	40 min	1 h 30 min
PAE-1:PAE-2 (60:40%)	HDT LV2: XFLO100 (50:50%)	52 min	3 h
PAE-1:PAE-2 (50:50%)	HDT LV2: XFLO100 (50:50%)	56 min	3 h 40 min
PAE-1:PAE-3 (80:20%)	HDT-LV2: XFLO100 (50:50 %)	42 min	1 h 20 min
PAE-1:PAE-3 (60:40%)	HDT-LV2: XFLO100 (50:50 %)	47 min	2 h 30 min
PAE-1:PAE-3 (50:50%)	HDT LV2: XFLO100 (50:50%)	55 min	2 h 40 min
PAE-1:PAE-2 (60:40%)	HDT LV2: XFLO100 (50:50%)	52 min	3 h
PAE-1:PAE-2 (60:40%)	HDT LV2: XFLO100 (60:40%)	48 min	2 h 18 min
PAE-1:PAE-2 (60:40%)	HDT LV2: XFLO100 (70:30%)	43 min	2 h

PENDULUM HARDNESS

PAE	Polyisocyanate	Glass (seconds)	Metal (seconds)
PAE-1	HDT-LV2	350	302
PAE-2	HDT-LV2	347	352
PAE-3	HDT-LV2	90	67
PAE-1:PAE-2 (60:40%)	HDT-LV2: XFLO100 (50:50 %)	211	241
PAE-1:PAE-3 (60:40%)	HDT-LV2: XFLO100 (50:50 %)	121	97
PAE-1:PAE-2 (80:20%)	HDT-LV2: XFLO100 (50:50 %)	226	263
PAE-1:PAE-3 (80:20%)	HDT-LV2: XFLO100 (50:50 %)	220	190

GLOSS MEASUREMENTS

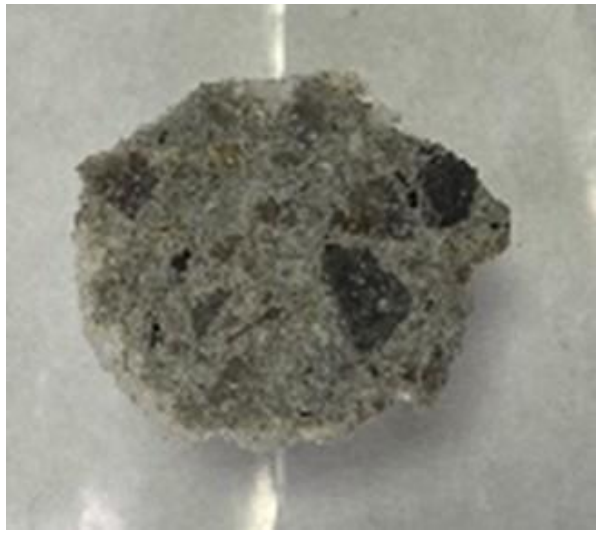
PAE	Polyisocyanate	Glass 60º (GU)	Metal 60º (GU)
Original surface			55.6
PAE-1	HDT-LV2	200.1	107.5
PAE-2	HDT-LV2	206.6	101.3
PAE-3	HDT-LV2	199.7	108.5
PAE-1:PAE-2 (80:20%)	HDT-LV2: XFLO100 (50:50 %)	203.9	101.4
PAE-1:PAE-3 (80:20%)	HDT-LV2: XFLO100 (50:50 %)	195.6	104.1

ADHESION TESTS

Sample	Surface	Dolly Dimension (mm)	Pressure (psi)
PAE-1C*	Concrete	20	962
PAE-2C**	Concrete	20	1083

* PAE 1: PAE2 (60:40) / HDTLV2 (NCO:NH ratio 1.1:1)

** PAE 1: PAE2 (60:40) / HDTLV2: XFLO 100 (NCO:NH ratio 1.1:1)



STARTING FORMULATIONS

Clear coat

COMPONENT A		
No	Raw Material	% Kg
1	PAE-1	44.5
2	Silicone surface additive	0.1
3	Hindered amine light stabilizer	0.6
4	UV absorber	1.2
5	Moisture scavenger	0.8
6	Butyl acetate + xylene (solvent)	9.8
	Subtotal for component A	57
COMPONENT B		
7	HDT-LV2	32.7
8	Methoxypropylacetate: butyl acetate (1:1)	10.3
	Subtotal for component B	43
	Total	**100**

Recommended mixing procedure

1. Homogenize the components before the mixing
2. Always blend component B (polyisocyanate) into component A (amine part)
3. After mixing, refill into a neutral container and mix again to avoid the non-mixed material from being applied.
4. Mixing tools: Standard 2K mixing equipment

Pigmented top coat

COMPONENT A		
No	Raw Material	% Kg
1	PAE-1	21.98
2	PAE-3	7.32
3	Moisture scavenger	3.0
4	Reactive Diluent	3.0
5	Silicone free defoemer	0.9
6	Solvent-free wetting agent	1.0
7	Barium sulphate, 5 microns	10.4
8	Talc, 5 microns	4.2
9	TiO_2	8.1
10	Iron oxide yellow (pigment)	7.3
11	Surface additve	0.2
12	Non-reactive diluent	6.0
	Subtotal for component A	73.4
COMPONENT B		
7	HDT-LV2	15.96
8	X-FL100	10.65
	Subtotal for component B	26.6
	Total	**100**

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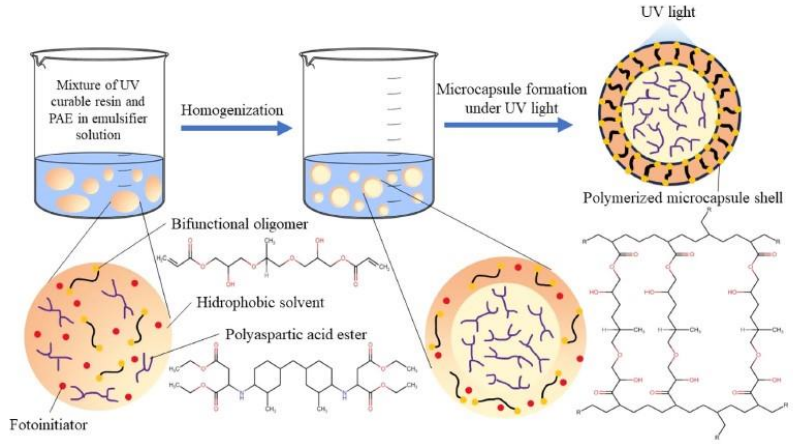
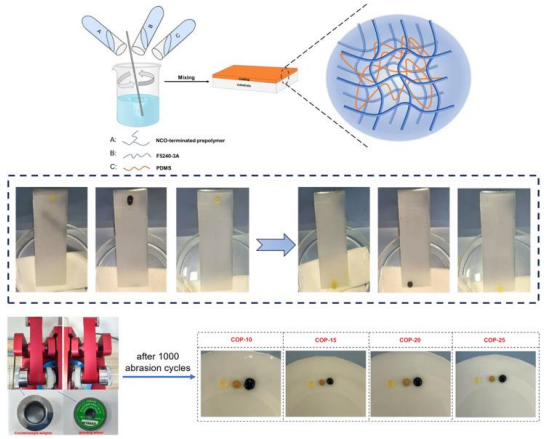
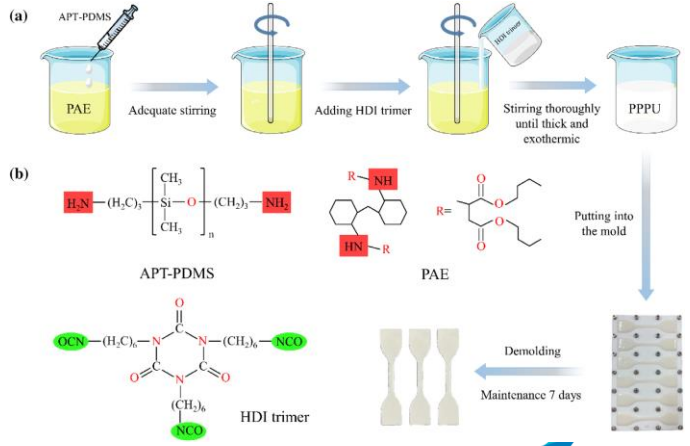
RECENT DEVELOPMENTS

- Microencapsulation of polyaspartic esters and their applications[8,9]
- Waterborne dispersions of polyaspartic esters [10,11]
- Adhesive and sealant applications with improved properties[12]
- Antifouling applications [13]







REFERENCES

1) M. Aubert, P. Setiawan, A .A. Oktaviana, A. Brumm et al. *Nature* **2018**, 564, 254–257.

2) https://www.ddcoatings.co.uk/3852/history-protective-coatings

3) Zwiener C., Pedain J., Kahl L. Nachtkamp K. Process for the preparation of coatings. Bayer *EP0403921A2* **1990**.

4) U. Meier-Westhues, K. Danielmeier, P. Kruppa, E. P. Squill Polyurethane Coatings **2019**,Vincentz Network

5) C.T. Williams, D. A. Wicks, W.L. Jarrett *J. Coat. Technol. Res.* **2009**, 6, 37–45.

6) https://www.cognitivemarketresearch.com/polyaspartic-coatings-market-report

7) https://www.aisc.org/globalassets/modern-steel/archives/2018/10/polyasparticcoatings.pdf.

8) L. Pastarnokienė, E. Potapov, R. Makuška, T. Kochanė, *J. Appl. Polym. Sci.* **2024**, 141, e55216.

9) M. Guo, Y. He, J. Wang, X. Zhang, W. Li *J. Appl. Polym. Sci.* **2020**, 137, 48478.

10) J. Park, D. Im, Y. Jin, S. Jang, H. Lim, W. K. Lee *Molecular Crystals and Liquid Crystals* **2019**, *688*, 1–6.

11) Suri C., Rulong Z., Xiaoyng Q. Et.al. *Water-dispersed polyaspartic acid ester resin, preparation method, and water-based paint.* Henzen Feiyang Juyan New. Mat. Co. Ltd. *CN117801199A* **2024**.

12) Z. Wang, M. Du, H. Fang, P. Zhao, X. Yao, S. Chen, *J. Appl. Polym. Sci.* **2024**, 141, e55668.

13) X. Han, y. Hu, Cren, L. Wang, L. Wu, A. Sun, Z. Li,, X. Liu, M. Yu *Colloids Surf. A: Physicochem*. Eng. **2025**, 717, 136751

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