

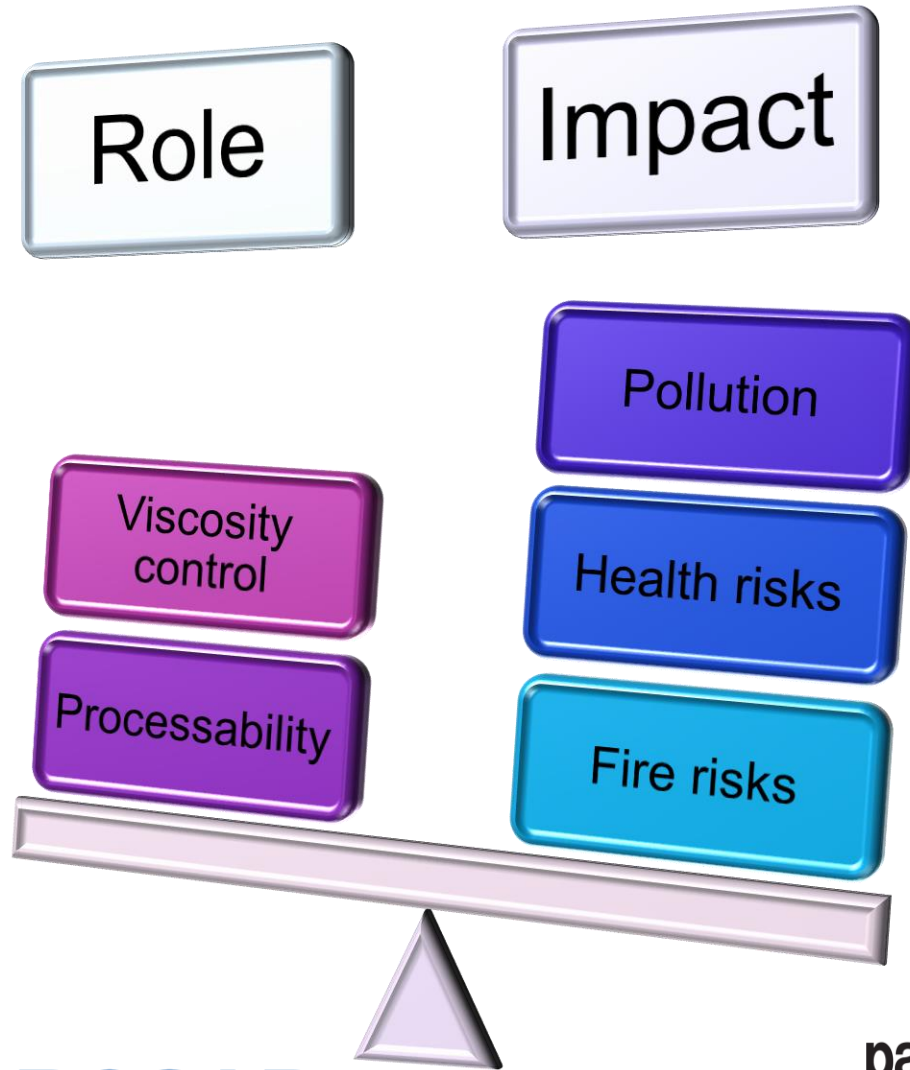
paintistanbul TURKCOAT CONGRESS

Metal-organic framework (MOF)-incorporated Polyaspartic ester coatings: Improved mechanical strength, corrosion resistance and flame retardancy

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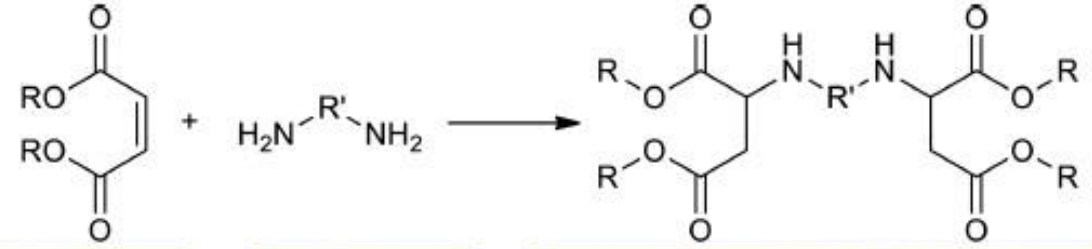
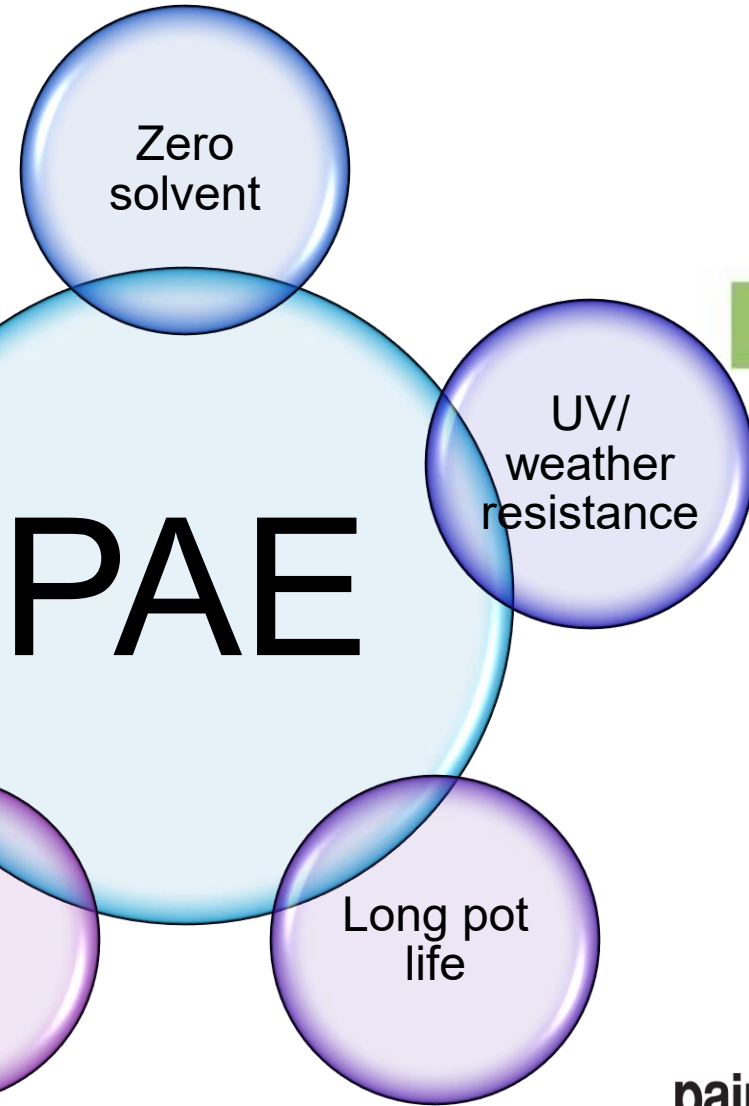
Izel Kimya A.S.

Solvents in resin industry



Solvent	Health	Flammability
Toluene	2	3
Xylene	2	3
Acetone	1	3
Isopropyl Alcohol (IPA)	1	3
Methyl Ethyl Ketone (MEK)	2	3
MIBK	2	3
Cyclohexanone	2	2
Ethanol	2	3

Polyaspartic Ester (PAE) Resins



Di(m) etil Maleat
Dimethyl maleate

Diamin
Diamine

Poliaspartik ester (alifatik diamin)
Polyaspartic ester (aliphatic diamine)



Challenges with PAE Resins

Insufficient Thermal Stability

- PAE resins may degrade at elevated temperatures, especially in fire-prone applications.

Low Flame Retardancy

- PAE resins are **organic in nature** and can ignite easily.

Moderate Chemical Resistance

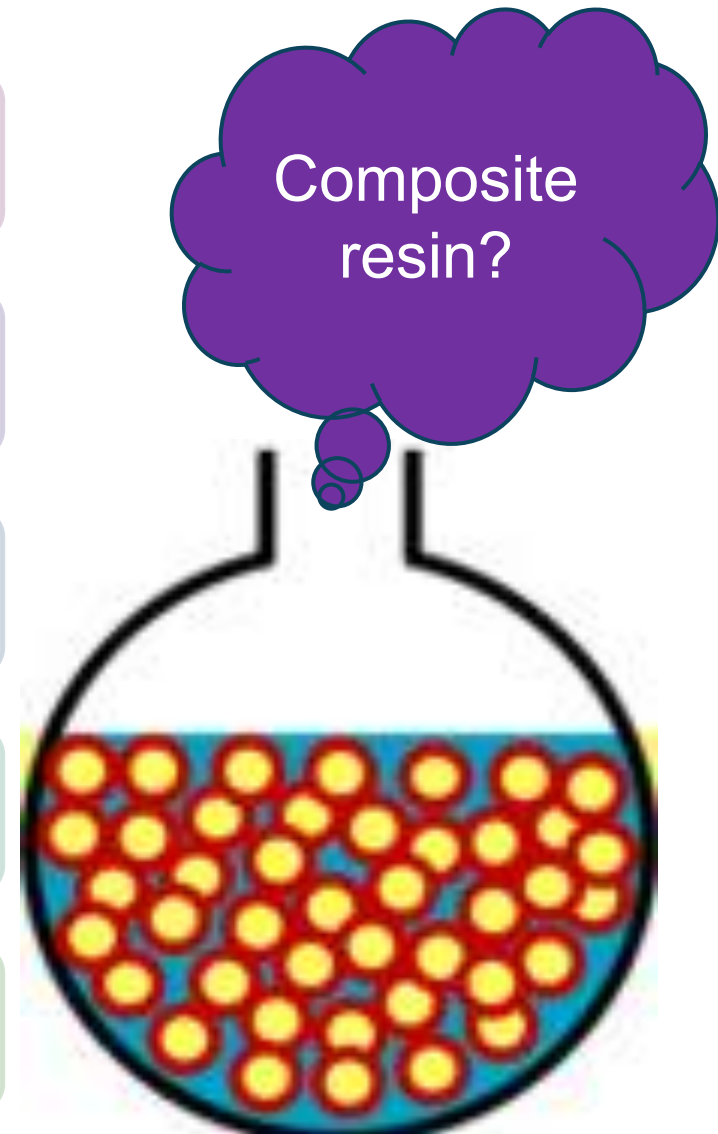
- PAE coatings can be vulnerable to aggressive solvents, acids, or bases.

Mechanical Reinforcement Needed

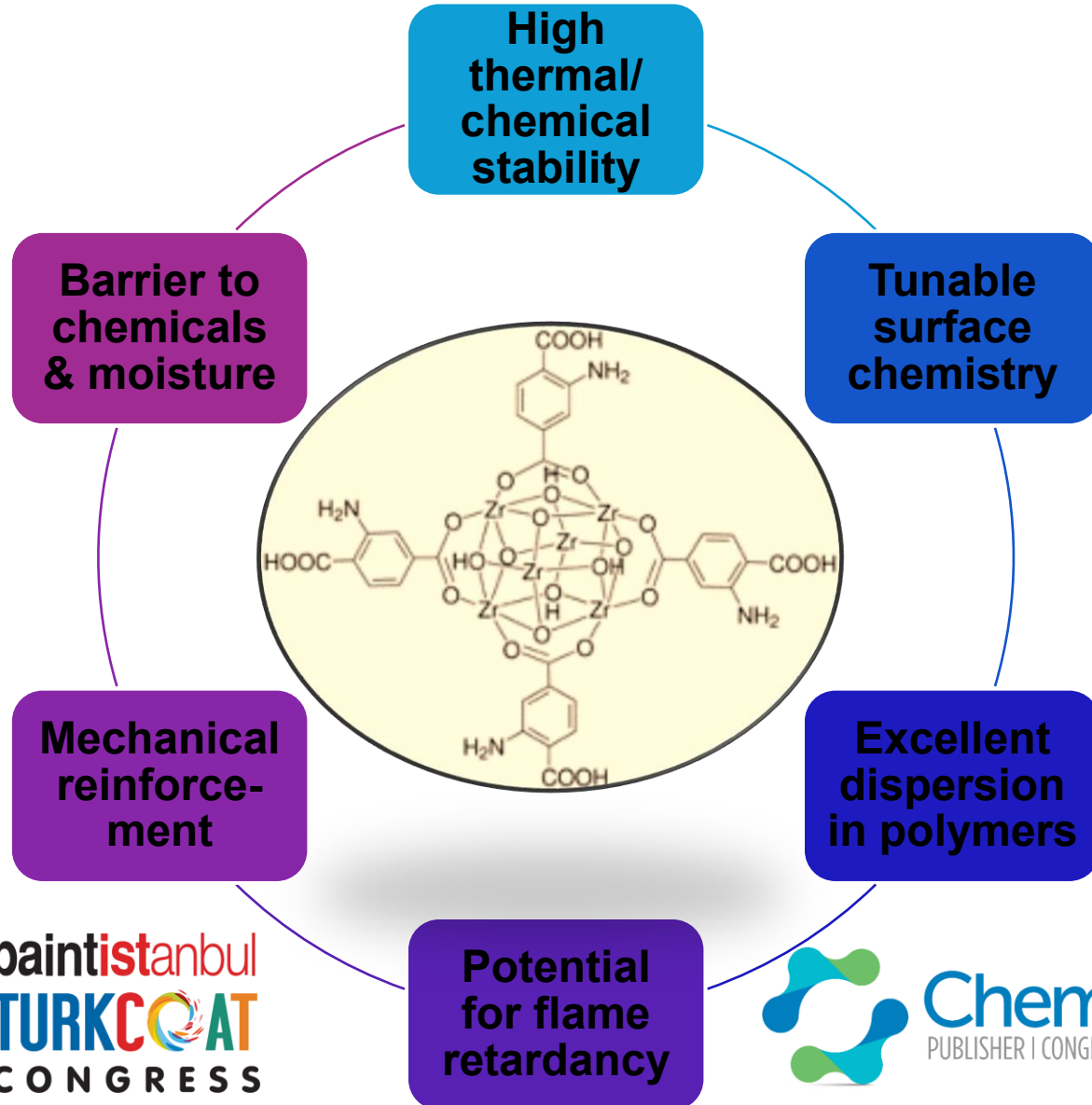
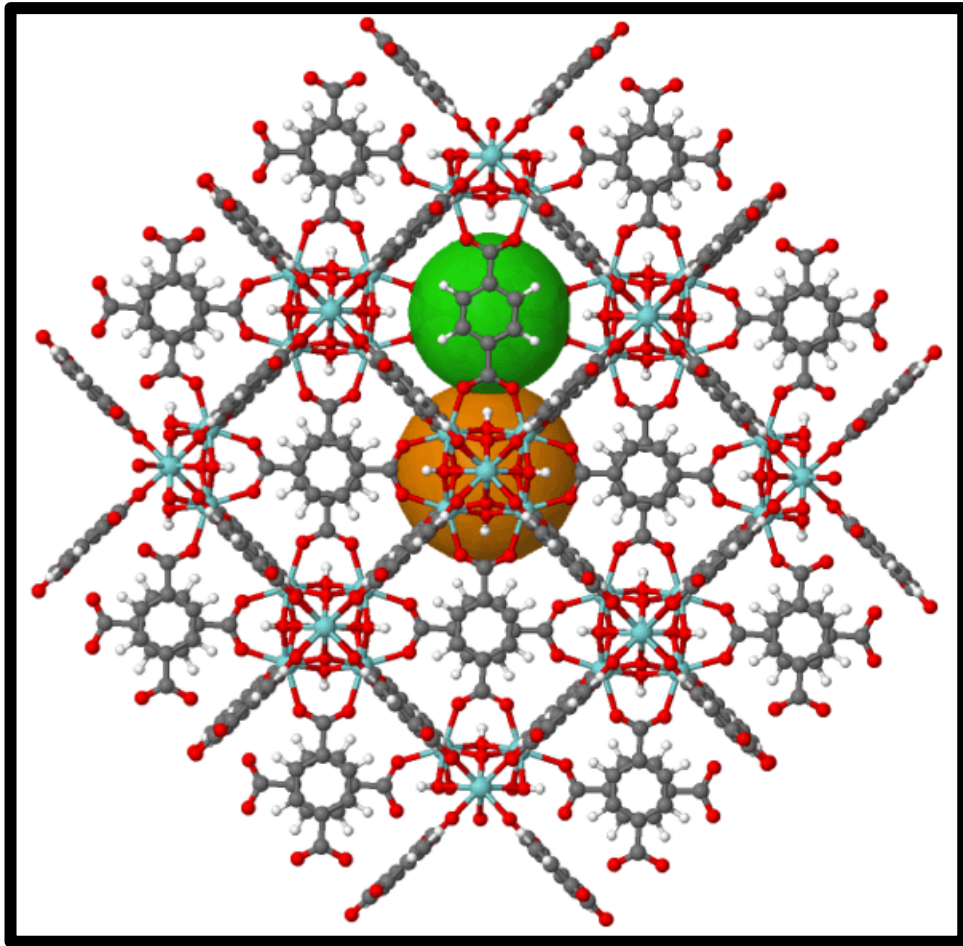
- Some PAE systems lack adequate **tensile strength or scratch resistance** for heavy-duty applications.

Barrier Properties

- PAE coatings may permit **moisture or oxygen ingress** over time.

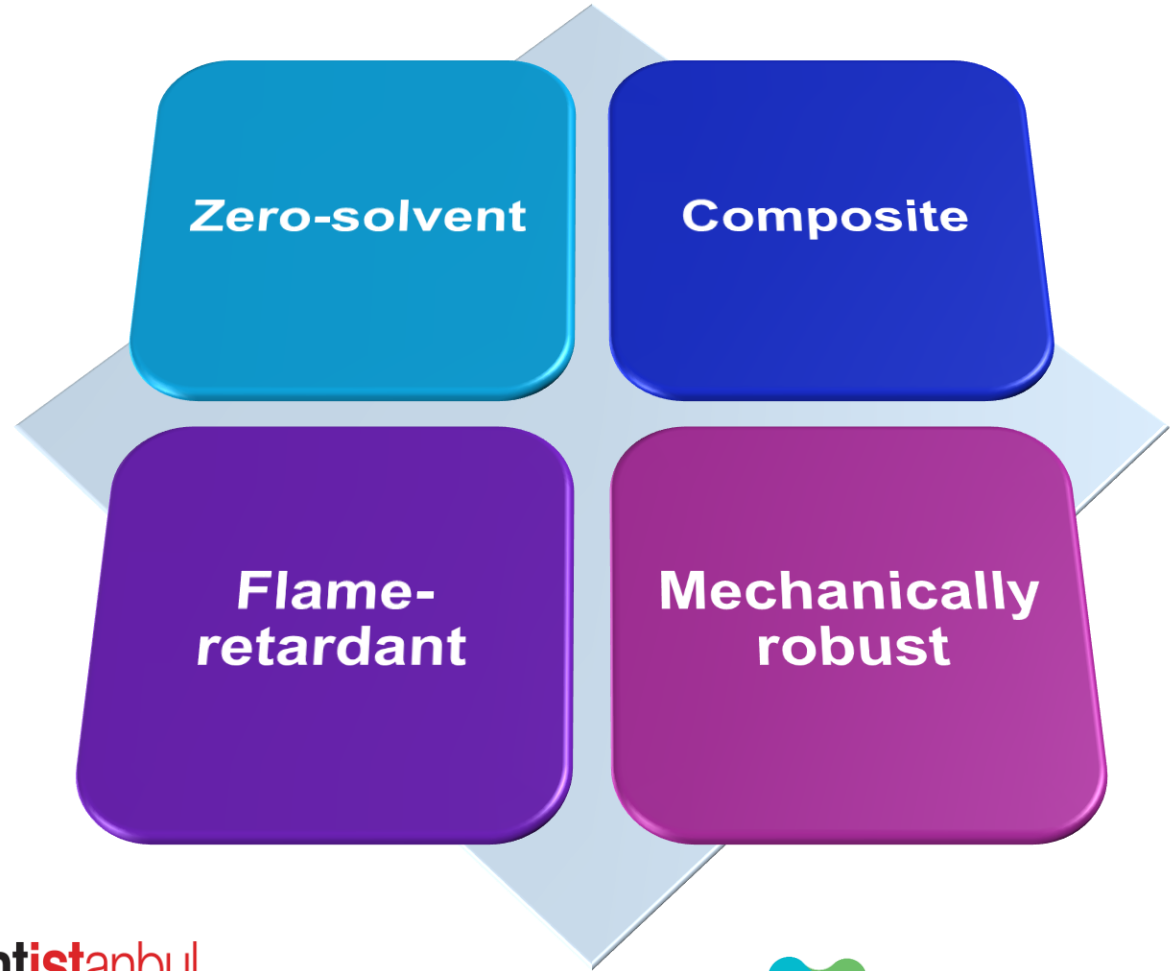


Metal-Organic Framework (MOF)

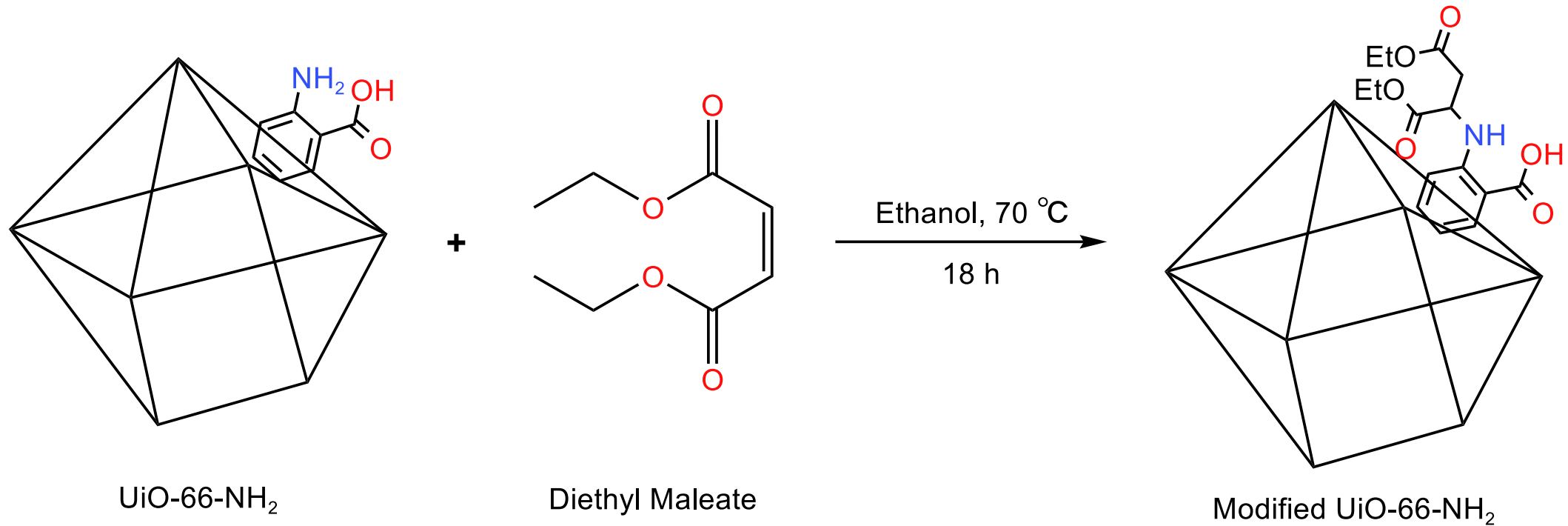


Objectives

- Modify UiO-66-NH₂ with DEM.
- Develop composite resin made of DEM-UiO-66-NH₂ and commercial PAEs.
- Evaluation of thermal, mechanical, chemical properties and flame retardancy



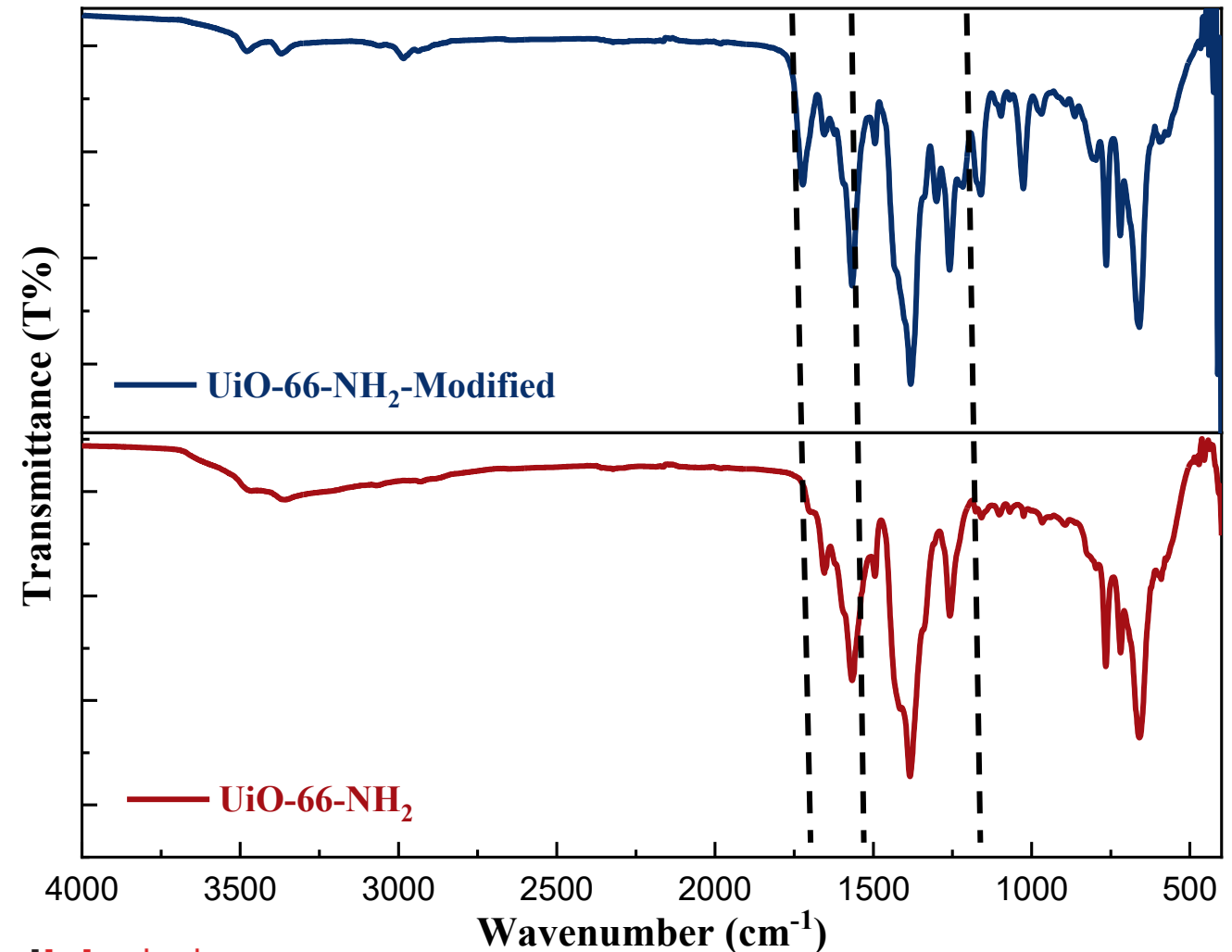
Experimental



- 1%, 2%, and 4% of the modified MOF is incorporated into two commercial polyaspartic resins using ultrasonic homogenizer.
- FTIR, WCA, Tensile testing, hardness, gloss, impact resistance, LOI, TGA is performed

Results

Wavenumber (cm ⁻¹)	Assignment	Change Upon DEM Modification
~1700	C=O (Ester/Carbonyl)	New peak appears → from diethyl malonate ester group
~1550	-NH ₂ bending (UiO-66-NH ₂)	Shifted → reaction with DEM via amidation or hydrogen bonding
~1100	C-O (ester) stretching	New peak → from DEM's ethyl ester groups



➤ **Successful modification of MOF**

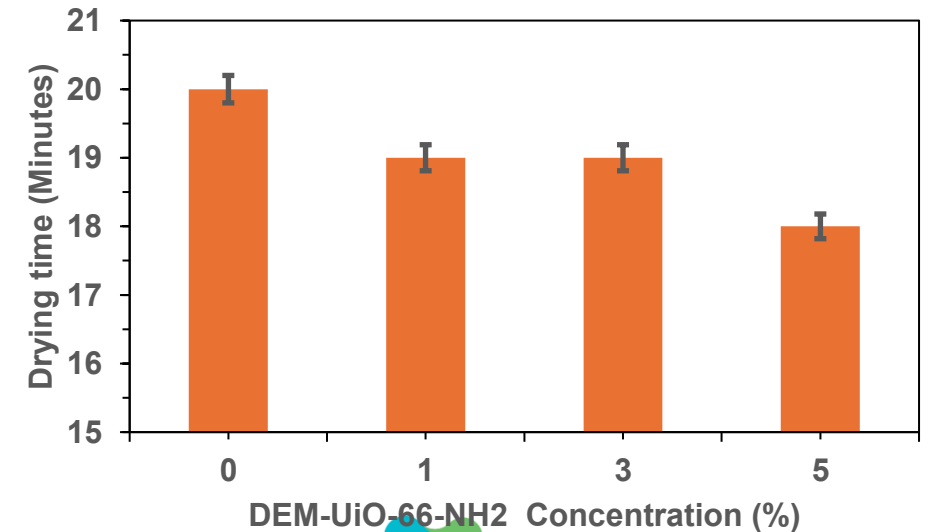
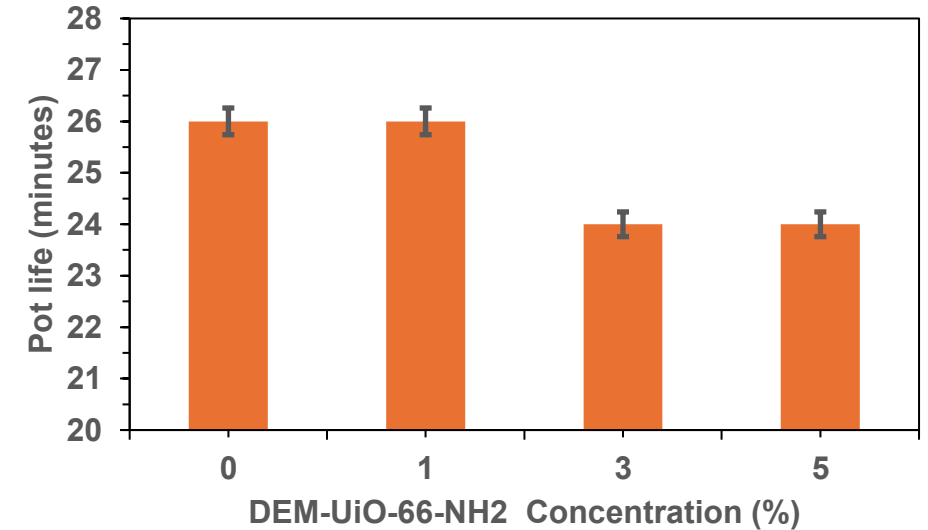
Results

MOF concentration	Gloss (20°/60°/85°)	Conical bending	Impact resistance	Cross Cut (Al/Gal/Saç)
0	7/31/89	0	2	2/1/0
1	7/29/76	0	2	2/1/1
3	7/29/78	0	2	2/1/0
5	8/32/75	0	2	2/1/0

- The maintained gloss at standard measurement angles indicates that the UiO-66-NH₂ particles are likely well-dispersed at a scale that doesn't significantly disrupt the coating's surface uniformity.
- Impact resistance maintenance suggests the coating retains its ability to absorb and distribute energy without failure, maintaining both flexibility and cohesive strength
- Similar cross cut results confirm that adhesion to the substrate remains uncompromised, which is critical for coating longevity and performance
- Comparable conical bending performance demonstrates that the coating flexibility and elongation properties are preserved, indicating the MOF particles aren't creating brittle points or stress concentrations

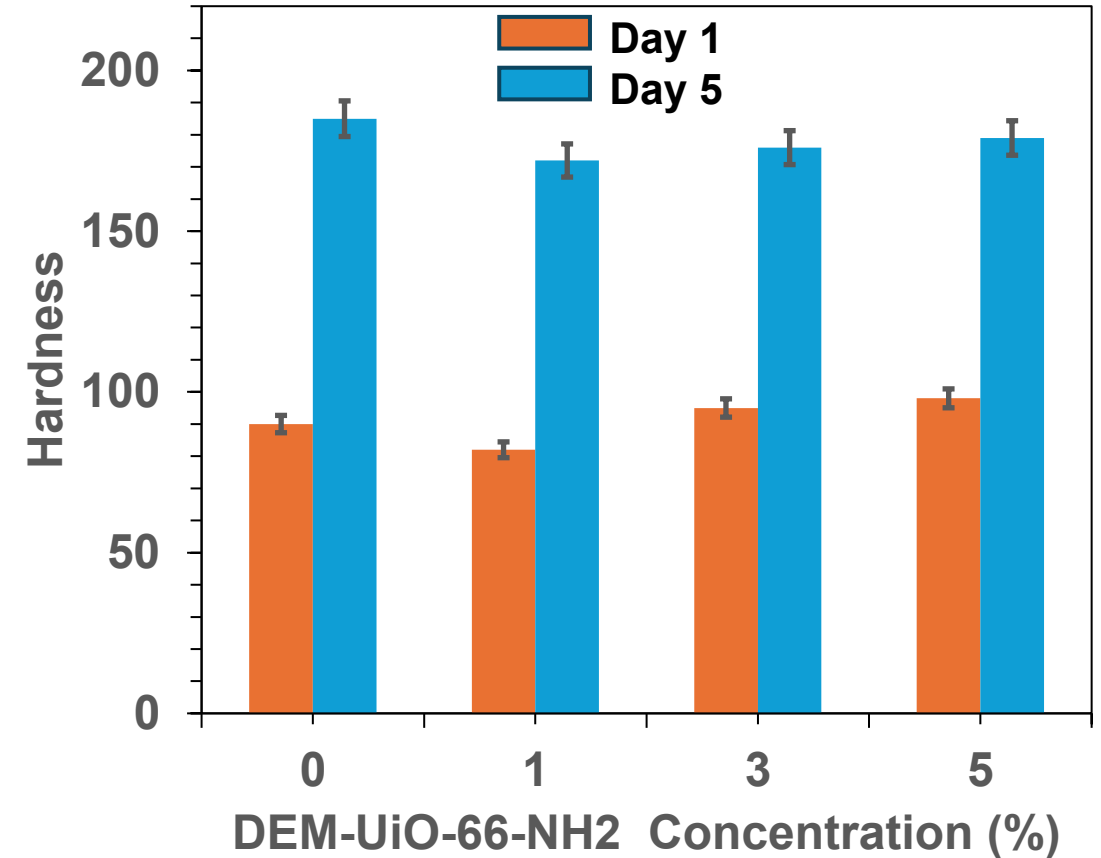
Results

- The UiO-66-NH₂ particles may be having a mild **catalytic** effect on the polymerization reaction between the isocyanate and aspartic ester components. The amino groups on the MOF could potentially interact with either component.
- The active surface sites on the MOF might be **accelerating the crosslinking process** slightly.



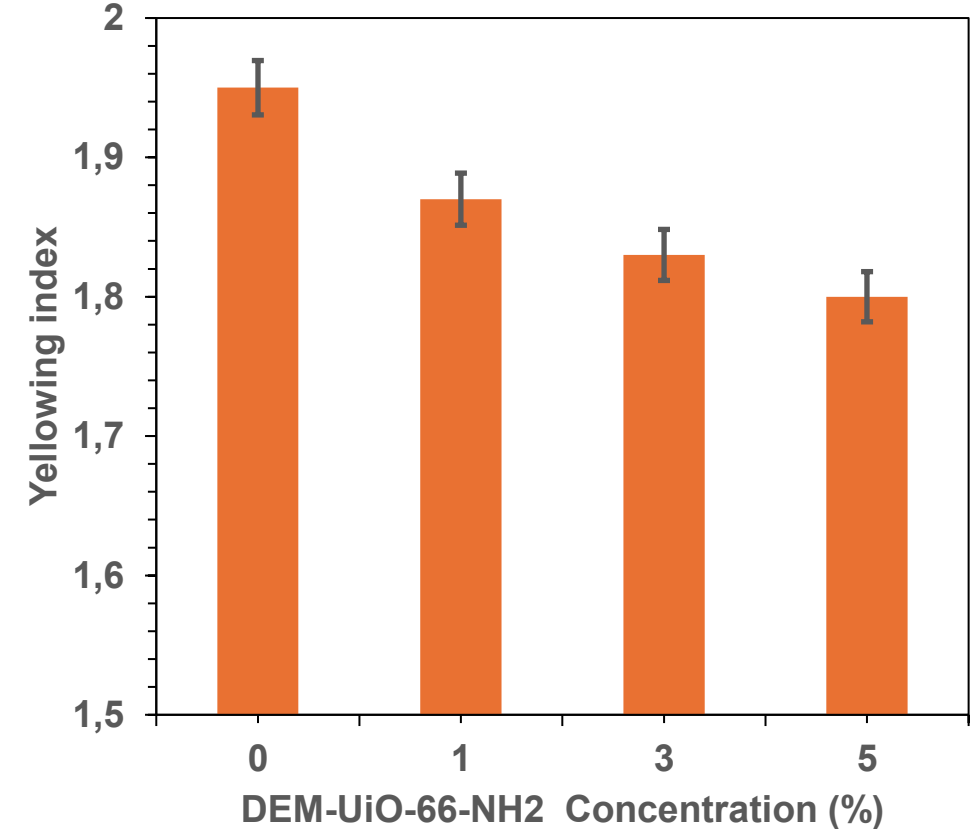
Results

- The crosslinking density of the polyaspartic network is likely unchanged despite the slightly altered cure kinetics
- The UiO-66-NH₂ particles are well integrated into the polymer matrix without creating significant weak points or interfering with network formation
- The fundamental mechanical properties of the coating remain intact, which is critical for durability and service life



Results

- **UV absorption/scattering** - The MOF may be absorbing or scattering harmful UV radiation that typically causes yellowing
- **Free radical scavenging** - The amino groups could be acting as sacrificial sites for free radicals that would otherwise attack the poly aspartic chains
- **Stabilization** of the polyaspartic matrix through hydrogen bonding with the amino groups



Conclusion and Future Study

The modified coating system now demonstrates a remarkable balance of properties:

- Enhanced yellowing resistance
- Preserved mechanical integrity (hardness, impact, flexibility, adhesion)
- Maintained aesthetic properties (with only minor changes at 85° gloss)
- Slightly faster cure (potentially advantageous for application efficiency)



thanks