Coatings Trends & Technologies SUMMIT

Cure-on-Demand Technologies in the Coatings Industry

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ChemQuest

actionable insights for success

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Agenda

- The What and Why of Cure-on-Demand Coatings
- Market Size
- Cure-on-Site Floor Coatings
- Thermal Frontal Polymerization (FP)
- Cure-on-Site FP Examples in Action

The ChemQuest Advantage:

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100% of our work is proprietary, offering a full portfolio of services under NDA

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- Build enterprises that challenge established thinking and drive transformation.
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- Be successful — because our success emanates from yours.

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The What and Why of Cure-On Demand Coatings

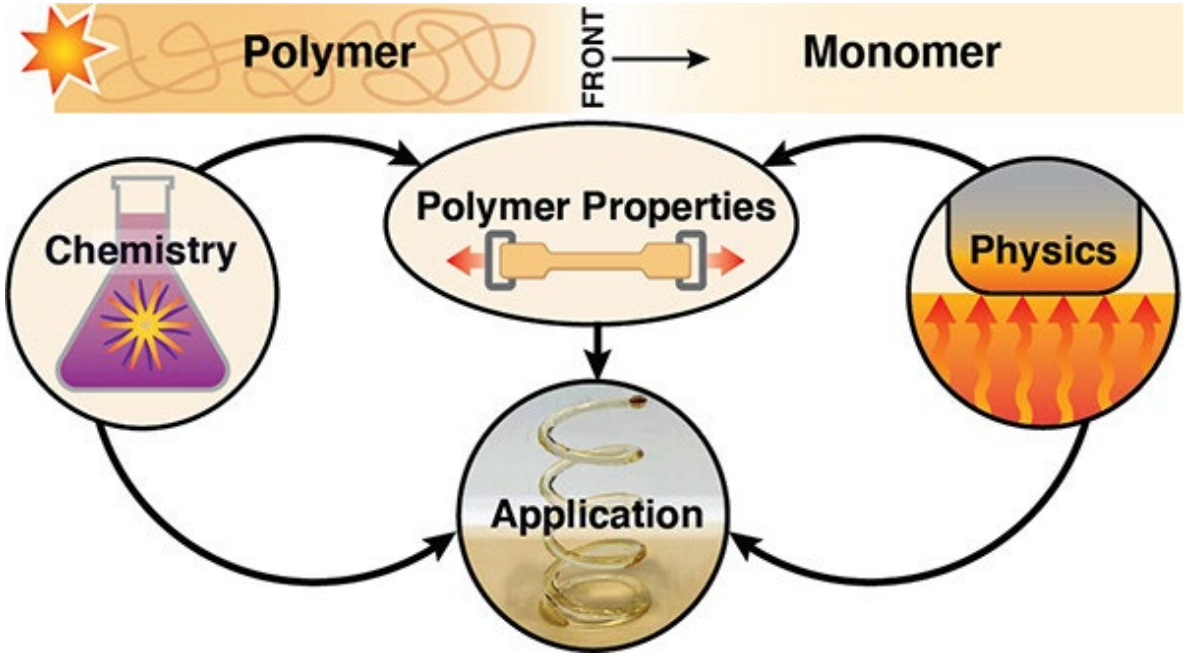
What Are Cure-on-Demand Coatings?

- **Cure-on-demand coatings (CoDs) are systems that remain uncured or partially cured until activated by a specific external stimulus.**

  UV light, heat, moisture, or electric current

- **Allows for precision in timing and location of cure**

- **These coatings are ideal for applications requiring:**
  - Long working time
  - Minimal waste
  - Rapid processing



Source: American Chemical Society, A Review: Frontal Polymerizations: From Chemical Perspectives to Macroscopic Properties and Applications, February 2023

Efficient – Precise – Durable – Customizable

Why Use Cure-on-Demand Coatings?

Minimized Downtime
(rapid return to service)

- **Need:** Schools, hospitals, retail stores, and sports facilities cannot afford long shutdowns.
- **Solution:** Cure-on-demand coatings can be fully cured within minutes to hours, compared to days for traditional polyurethanes or epoxies.
- **Benefit:** Immediate foot traffic; gym floors and retail aisles can reopen same-day, maximizing facility uptime.

Environmental & Regulatory Compliance

- **Need:** Stricter VOC regulations (especially in California, Canada, EU) are pressuring users to move away from solvent-based finishes.
- **Solution:** UV-cured and waterborne cure-on-demand finishes are low- or zero-VOC.
- **Benefit:** Contractors stay compliant without sacrificing performance, and end users can safely occupy the space sooner.

Performance
(durability and aesthetics)

- **Need:** High-traffic areas demand scratch resistance, chemical resistance, and a long-lasting appearance.
- **Solution:** UV-cured coatings offer superior hardness and abrasion resistance compared to many traditional finishes.
- **Benefit:** Extended life cycles for gym, retail, and showroom floors with less maintenance.

Labor Efficiency & Predictability

- **Need:** Skilled labor shortages make repeatable, efficient application methods more valuable.
- **Solution:** Portable LED UV systems standardize curing regardless of humidity or ambient temperature.
- **Benefit:** Reduces rework, weather delays, and reliance on perfect conditions, while enhancing jobsite efficiency.

Marketing & Value Differentiation for Contractors

- **Need:** Flooring professionals need to stand out in competitive markets.
- **Solution:** Offering UV-cured systems positions contractors as technologically advanced, health-conscious, and green-friendly.
- **Benefit:** Higher-end offerings justify premium pricing while delivering measurable ROI to clients through faster completion and better floor life.

Sustainability & LEED Credits

- **Need:** Clients demand sustainable, healthy materials and finishes in schools, government buildings, and commercial spaces.
- **Solution:** Cure-on-demand coatings often help achieve LEED credits for low emissions and rapid construction turnover.
- **Benefit:** Appeals to green-building stakeholders and institutional buyers.

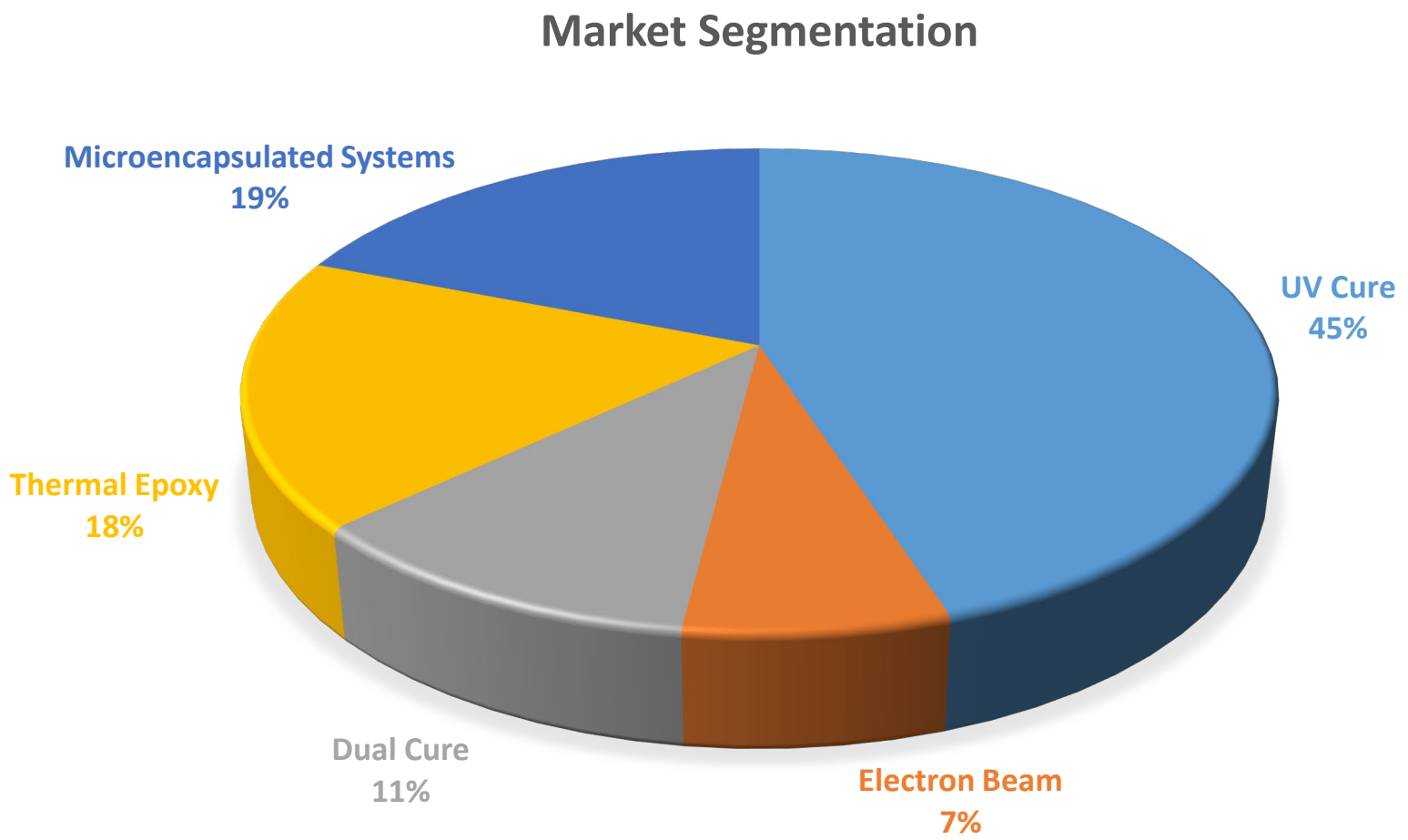
Major Cure-on-Demand Chemistries

Cure Mechanism	Chemistry Type	Typical Triggers	Key Components/ Materials	Common Substrates
UV cure	Acrylates, epoxies	Ultraviolet light (200-400 nm)	Photoinitiators, acrylate monomers/oligomers	Wood, plastic, metal, glass
EB cure	Acrylates, epoxies	Electron beam	No photoinitiator, low-VOC oligomers	Paper, film, industrial laminates
Thermal cure	Epoxies, polyurethanes	Heat (80-200 °C)	Latent hardeners, blocked isocyanates	Metal, composites
Moisture cure	Silanes, polyurethanes	Ambient humidity	Moisture-reactive prepolymers (e.g., siloxanes)	Concrete, wood
Redox cure	Epoxies, unsaturated polyesters	Two-component (initiator + catalyst)	Benzoyl peroxide, amines	Metal, composites
Catalyst-on-demand	Polyurethanes, epoxies	Triggered catalyst release (heat, light, pH)	Microencapsulated catalysts	Varied
Dual-cure	Acrylates + epoxies or PUs	Light + heat/moisture	Hybrid resins for sequential cure	Electronics, automotive, adhesives

Market Size

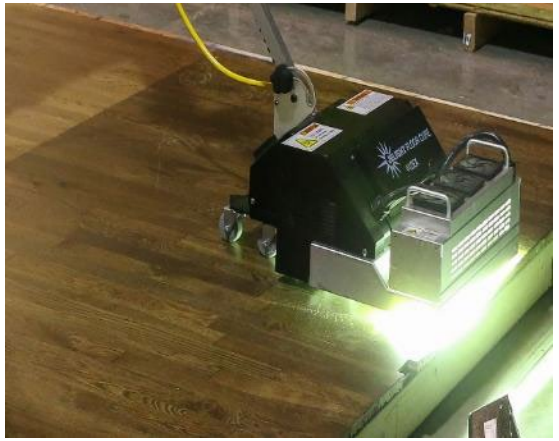
Cure-on-Demand Coatings 2024 Global Market

- **CoD 2024 global revenue: $16B (CAGR 5-6%)**
- **Regional segmentation**
  - APAC 37%
  - EU 27%
  - N. America 25%
  - LATAM/MEA 11%
- **Key growth drivers**
  - Environmental regulations
  - Electronics & automotive demand
  - APAC industrial expansion
  - Need for high-speed manufacturing
  - Emerging dual-cure technologies
    - Aerospace, medical, and industrial sectors



Cure-on-Site Floor Coatings

UV LED On-Site Floor Curing Systems



Sources: www.TVS-SportsSurfaces.com, Hardwood Floors Magazine, April 2022, Fine Homebuilding Magazine 2017

UV Floor Coatings & Equipment

With rapid advancements in LED UV technology, the flooring industry is now positioned to deliver next-day functionality with next-gen chemistry.

Waterborne UV-curable finishes

- Waterborne UV-curable finishes contain water as a solvent and dry to the touch by evaporation.
- The application of the finish is the same as most other waterborne finishes and usually is dry to the touch in two to four hours. The difference is the curing process.
- The water in that film must be evaporated completely prior to starting the curing process.
- The uncured dry film is somewhat soft but will withstand the UV curing equipment and light foot traffic. Curing happens when the dry film is exposed to the UV light.
- Once it is exposed, it is cured, and it can either be abraded for an additional coat or put into immediate use by the floor owner.

Cost of Equipment

Machine Type	Approximate Price Range
High-end motorized systems (e.g., CureUV, DecoRad)	$8,500 - $9,000
Mid-range portable trolleys (e.g., Birduv)	$3,500
Budget/consumer handheld units	$200 - $400

Sand – Clean – Apply – UV Cure

UV Field-Applied Cost vs. Traditional PUD

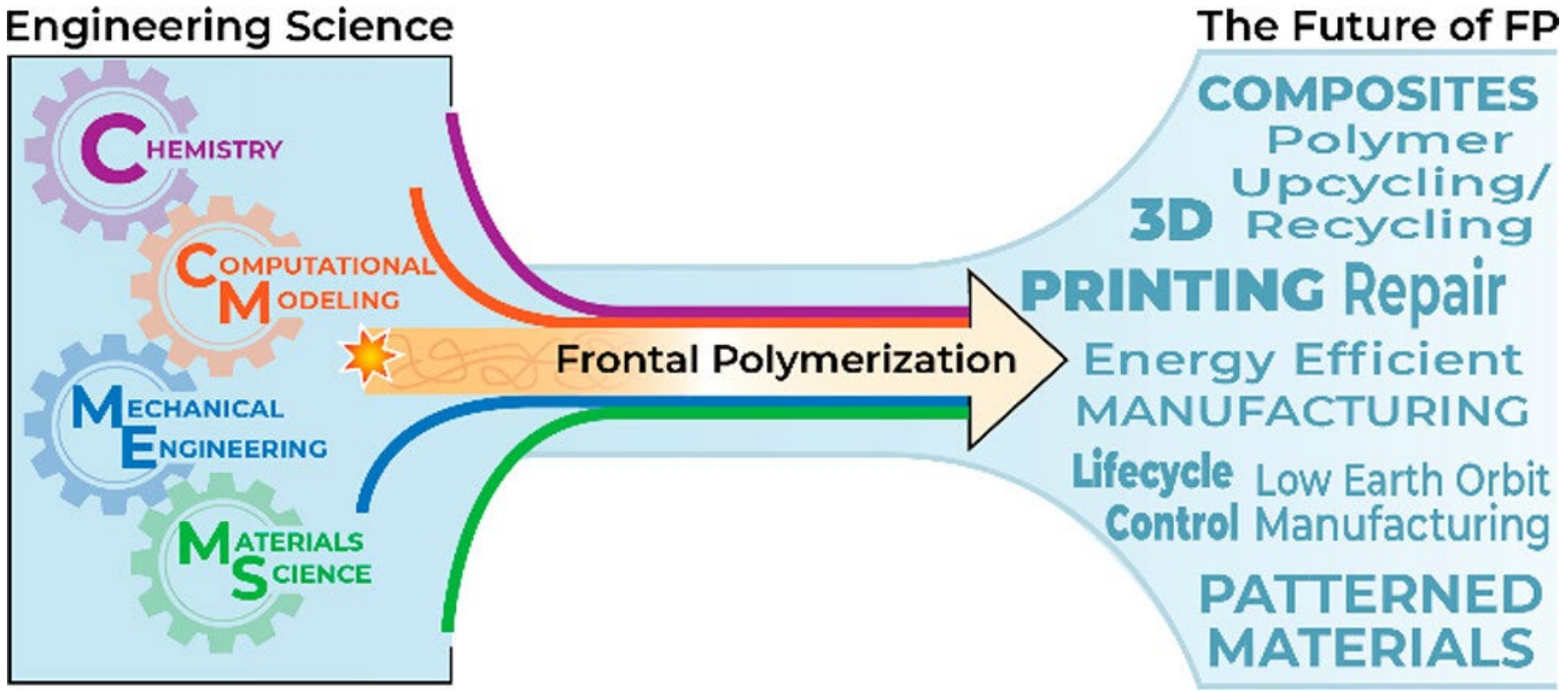
- **UV cure on-site costs per sq ft**
- **Typical gym size: 7,000 - 8,000 sq ft**

Breakdown of Estimated Costs
(UV-Cured System)

	Cost/Sq Ft
Labor (prep, sanding, coating)	$1.75 - $2.25
UV-curable finish materials	$1.25 - $1.75
UV equipment use/amortization	$0.50 - $0.75
Misc. (tape, graphics, cleanup)	$0.25 - $0.50
Total estimated cost	**$3.75 - $5.25**

Traditional polyurethane **$3.50**

Cure-on-Site Thermal Frontal Polymerization

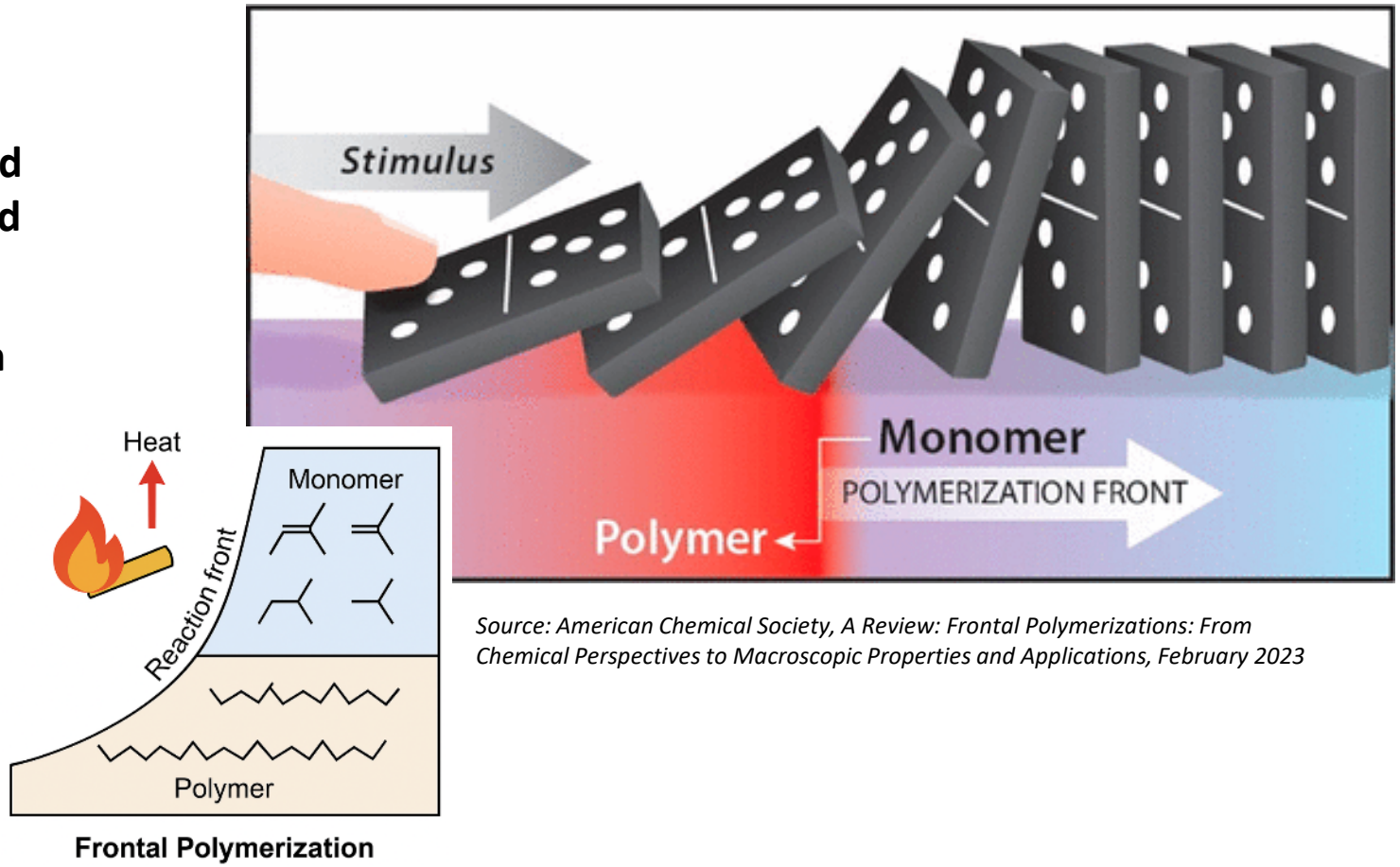


Source: American Chemical Society, A Review: Frontal Polymerizations: From Chemical Perspectives to Macroscopic Properties and Applications, February 2023

Thermal Frontal Polymerization

Frontal polymerization is a **self-propagating** polymerization method.

- **Heat generated from the polymerization of a small region of monomer sustains and propagates a reaction front into unreacted monomer.**
- **Once thermally triggered, the process can continue autonomously.**



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Frontal Polymerization Chemistry

1 Initiation

Thermal Trigger

- A localized heat source (like a soldering iron, resistive heater, or infrared laser) initiates the decomposition of a thermal initiator.
- Typical thermal initiators:
  - AIBN (azobisisobutyronitrile) *decomposes at ~65°C*
  - BPO (benzoyl peroxide) *decomposes at ~90°C*
  - DTBP (di-tert-butyl peroxide) *decomposes at ~120°C*
- This generates free radicals, starting the polymerization of monomers in a localized area.

2 Propagation

Exothermic Polymerization Front

- The polymerization reaction is highly exothermic, especially in monomers like acrylates or epoxies.
- The heat from the reaction diffuses into adjacent unreacted monomer, raising its temperature, causing more initiator to decompose and continuing the chain reaction.
- Typical monomers:
  - Acrylates/methacrylates: e.g., methyl methacrylate (MMA), triethylene glycol dimethacrylate (TEGDMA)
  - Epoxies: e.g., DGEBA with anhydride or amine curing agents
  - Dicyclopentadiene (DCPD) (in ROMP-based FP)

3 Sustained Reaction Front

Liquid Polymerizes to Solid

- A sharp reaction front (1-10 mm thick) moves through the material at ~0.1-10 cm/min.
- Temperatures in the front can reach 150-300°C, depending on the system.
- The polymer behind the front is solidified, while ahead is still liquid monomer.

Examples of FP Chemistries

System	Monomer	Initiator	Notes
Acrylate	MMA, TEGDMA	BPO, AIBN	Fast front; commonly studied
Epoxy	DGEBA + hardener	DTBP	For structural applications
ROMP	DCPD	Grubbs catalyst + thermal trigger	Also used in frontal ring-opening metathesis polymerization

Thermodynamics & Kinetic Features

Property	Typical Value
Front temperature	150 - 300°C
Front velocity	0.1 - 10 cm/min
Activation energy	80 - 150 kJ/mol
Exotherm per mole	~50 - 100 kJ/mol for acrylates
Thermal diffusivity	Important for stable front propagation
Critical initiator concentration	Below which front won't sustain

FP Applications

- **3D printing / additive manufacturing**

  Cures complex shapes with minimal energy

- **Composite part production**

  CFRP parts in aerospace and automotive

- **Repair materials**

  On-demand, rapid-curing adhesives

- **Resins for construction**

  Crack repair, anchoring systems

- **Polymer clay for artists**

  New material for making art without using a kiln

Challenges to Consider

- **Front stability**

  Can be unstable or extinguish if heat is lost too quickly

- **Volatility**

  Gaseous byproducts (e.g., N_2 from AIBN) may cause porosity

- **Scalability**

  Heat dissipation becomes more difficult in large volumes

- **Safety**

  Local high temperatures and runaway reactions are possible

Practical Considerations

Heat Source and Application

- Must deliver localized heat without damaging nearby surfaces
- May require controlled equipment like heat guns, soldering irons, or infrared heaters

Material Thickness & Fillers

- Fillers (e.g., fumed silica, carbon fiber) help prevent convection and improve front stability
- High-density materials may slow front propagation

Control of Cure

- Proper design avoids front instabilities (e.g., waves, spin modes)
- Uniform curing depends on precise thermal management and resin viscosity

Safety

- High exothermic temperatures can cause localized hot spots
- Designs must mitigate runaway heat

Cure-on-Site FP Examples in Action

Pojman Polymer Products

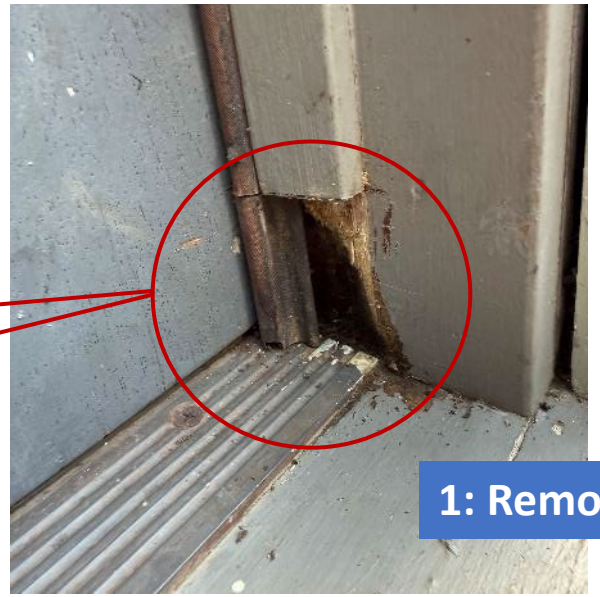
John Pojman, Ph.D.
LSU Chemistry Dept Chair

- **3P QuickCure WoodFiller** is the only “cure-on-demand” wood filler for the home repair professional or DIYer.
  - With its unlimited working time, 3P QuickCure Wood Filler allows you all the time you need to prepare the repair.
  - Once you heat the surface, the reaction spread and hardens the filler in seconds, no matter how deep the hole.

- **3P QuickCure Clay** is the only cure-on-demand modeling clay available on the market.
  - No kiln or oven is needed to create strong sculptures.
  - It can also be used to repair holes in floors, walls, and wood and can be used for DIY projects.

Cure-on-Site Example: Door Frame

Rotted Wood at Bottom of Door Frame



1: Remove rotted wood

Cure-on-Site Example: Door Frame

2: Fill gap and build layers of quick- cure wood filler using a putty knife and heat gun

Cure-on-Site Example: Door Frame

3: Hardened filler can be sanded, accepts screws, does not shrink or swell, and is immediately ready for painting

Cure-on-Site Example: Decking

Final Thoughts

On-site cure-on-demand technology offers many benefits.

- **Rapid, efficient energy curing**
- **On-demand processing and precision control**
- **Minimized downtime & rapid return to service**
- **Environmental compliance**
- **Performance and durability**
- **Compatibility with other advanced materials**
- **Labor efficiency where labor shortages exist**
- **Valuable differentiation for contractors**

Time is Money

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Thank You!
Questions? Comments?
Please reach out:

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