Thermal Management Coatings

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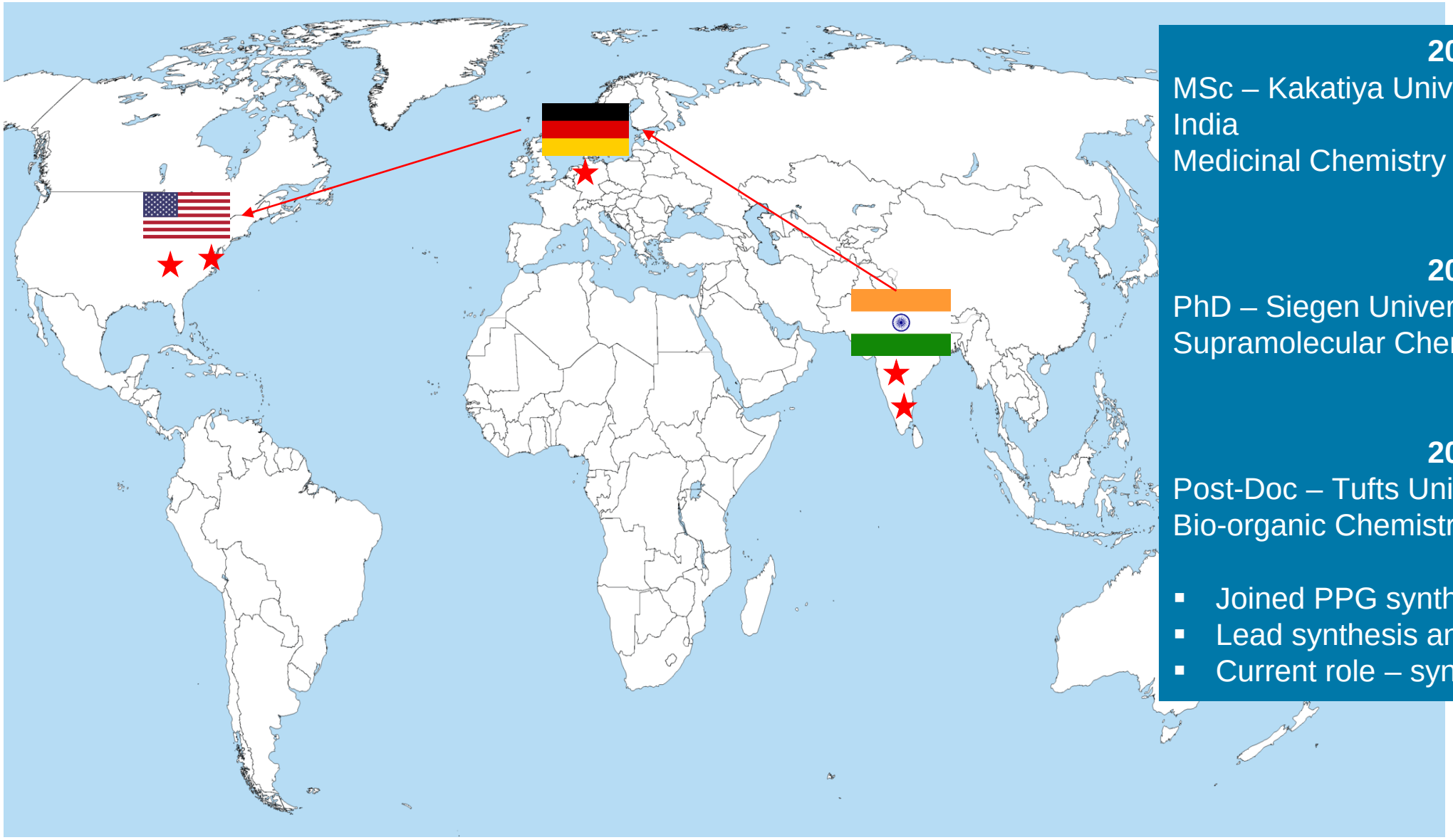
Scientist
PPG

Background



2000

MSc – Kakatiya University/IIT Mumbai – India
Medicinal Chemistry

2005

PhD – Siegen University – Germany
Supramolecular Chemistry

2007

Post-Doc – Tufts University – USA
Bio-organic Chemistry

- Joined PPG synthesis group
- Lead synthesis and formulation groups
- Current role – synthesis group

PPG paints and coatings are used to protect and enhance some of the world's best-known products and brands

World-renowned landmarks

Devices and screens all around you

The planes we fly in – from the windows to the exteriors

Passports and licenses

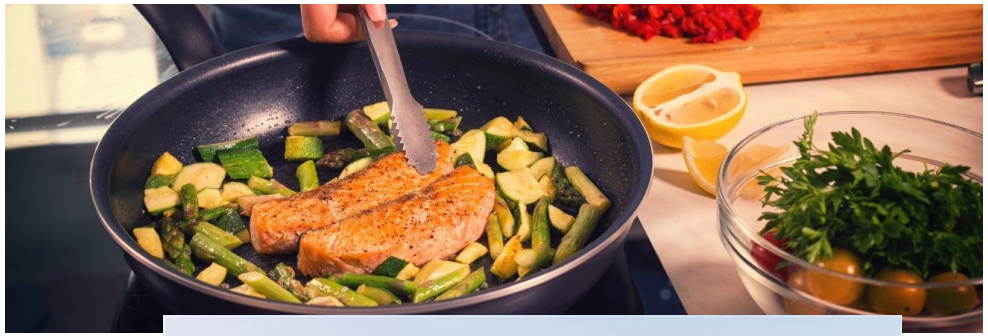
Cars we drive and the infrastructure to get where we're going

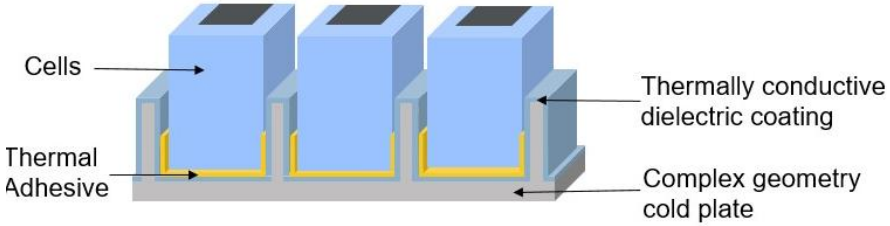
The homes we live in

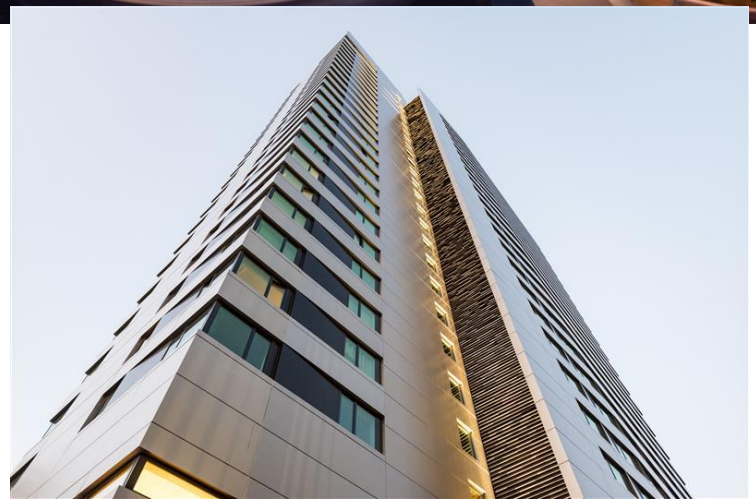
The offices we work in

The cans we drink from

Thermal Management







Agenda

- **Impact of Fire**
- **Fire Protection:** Active & Passive, Retardants & Intumescent
- **Intumescent Passive Fire Protection (PFP) Coating**
  - How does it work?
  - Differences between cellulosic and hydrocarbon PFP?
  - Where can it be used?
- **Need for Accelerated Test Methods, Future Trends & Reduction in Substances of Concern**
- **Summary**

Effects of Fire on Lives and Assets

The National Fire Protection Association (NFPA) U.S. estimates

- A fire department responds to a fire every **23 seconds**
- A home structure fire every **95 seconds**
- One civilian fire-related death occurs every **3 hours**
- In 2023, U.S. fire departments responded to **1.39 million fires**, estimated 3,670 civilian deaths and 136,350 injuries. Every year there are about 50 on-duty firefighter deaths.
- 2023: **$23B** property loss
- Worse metrics in developing countries

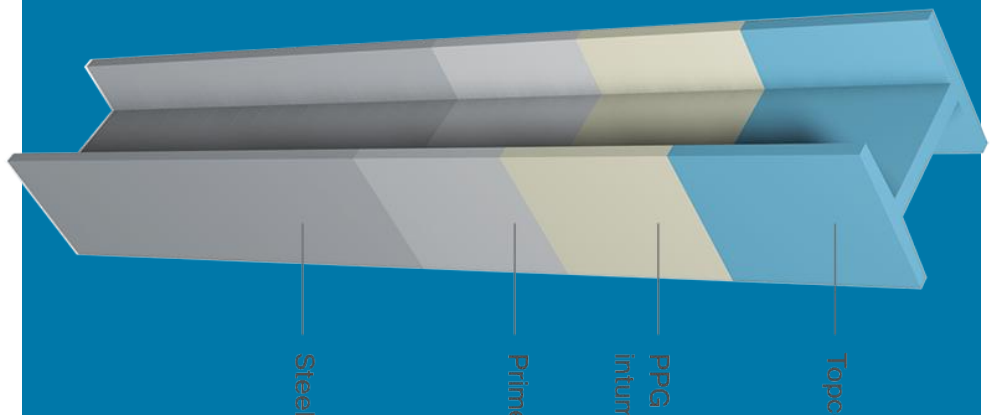
Fire Protection Methods

Active Fire Protection (AFP)

- Require action/motion to activate
- Fire/smoke alarm, sprinkler system, fire extinguisher, fire fighter

Passive Fire Protection (PFP)

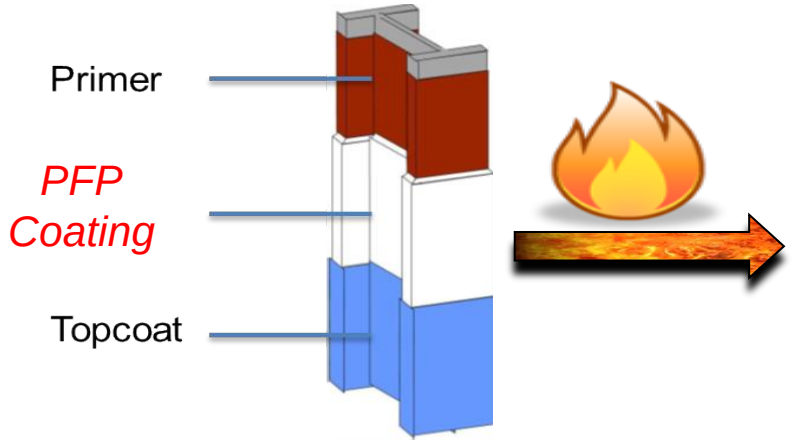
- No activation required
- Fireproofing steel structures, walls, floors, doors, etc.



AFP and PFP measures can substantially mitigate fire risks

Intumescent Coatings in Action

- Expands its volume when exposed to heat
- Creates insulation, and prevents steel from heating up rapidly
- Can save lives, protect investments and reduce downtime



Coating volume expands to produce thermal insulating barrier

PFP Charring Mechanism

20X to 50X original DFT

250 °C
APP → H3PO4+NH3

320 to 400 °C
H3PO4+Pentek
FORMS CHAR

100-200 °C
Resin softens & melts

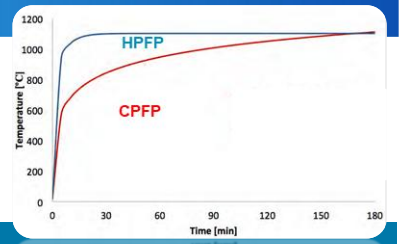
260 °C
Pentek Melts

200 to 370 °C
Melamine → NH3+CO2

550 °C
Char Structure
oxidizes to CO2

Multiple events to produce thermal barrier for substrates

Types of Fires



Cellulosic Fire Testing

- Civil constructions
- Fueled by wood, paper, textiles
- Reaches 945˚C after 60 minutes

Hydrocarbon Fire Testing

pool fire

- Petrochemical industries
- Fueled by oil and gas
- Reaches 1096˚C within 5 min

jet fire

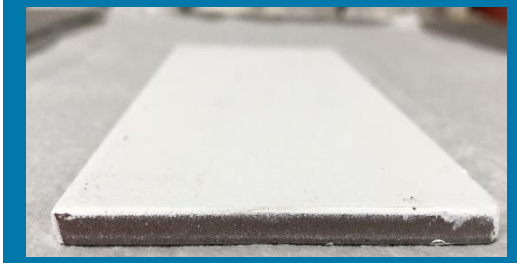
- Petrochemical industries
- Fueled by pressurized oil & gas
- Reaches >1200˚C within 5 min
- Explosion/Cryospill requirements

- **Steel structures start to lose their stability and integrity >400˚C**
- **Not every fire is the same**
- **Delayed heat transfer with PFPs!**

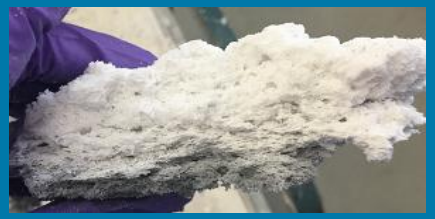
Cellulosic and Hydrocarbon

Char behavior differences

Cellulosic PFP



1 mm dry film thickness



- Subjected to cellulosic fire
- Expands 40-60 times original film thickness
- Char is highly porous, soft, fluffy

Hydrocarbon PFP

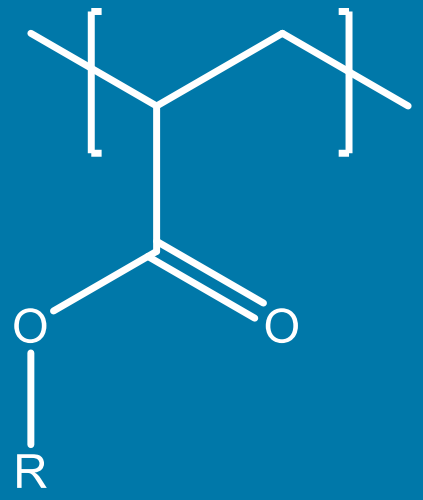
8 mm dry film thickness

- Subjected to hydrocarbon fire
- Expands 3-10 times original film thickness
- Char is hard, compact, dense

Chemistries designed to address various fire sources

Typical Resin Chemistries

Cellulosic PFP / SB & WB



Typically 1k: Thermoplastic

Hydrocarbon PFP

Typically 2k: Thermoset

Open Innovation Opportunities

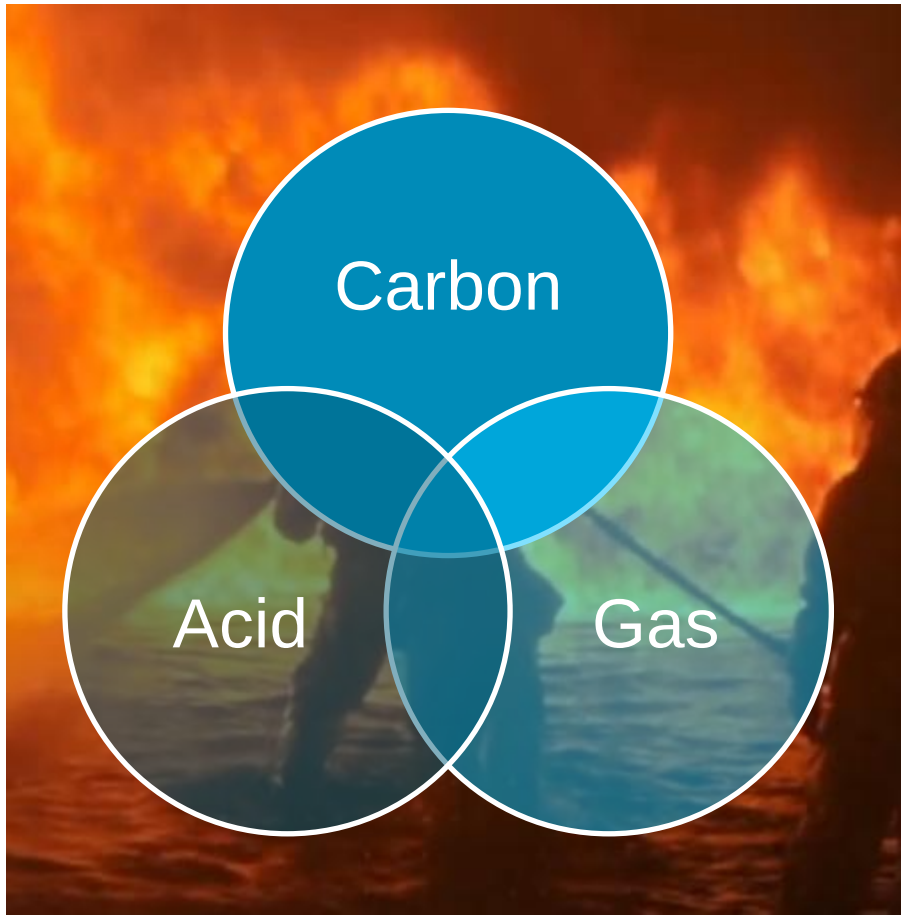
- Enhanced durability
- Less coats
- Faster return to service
- 2K or 1K
- Hybrid solutions

- **Waterborne, Solventborne, Solventfree Choices**
- **Fire source and durability dictate choice of chemistry**

Intumescent Coatings Key Components

3 key intumescent ingredients in a PFP coating

- Inorganic
  phosphoric; sulfuric; **boric**
- Organic
  phosphates; sulfates; borates



- -OH- rich organic compounds
  polyol; **pentaerythritol (PER)**; starch, dextrin; sorbitol; phenol resin

- N-rich organic compounds
  melamine; urea; dicyandiamide

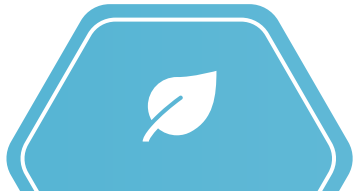
J. Coat. Technol. Res., 2018, 14(1)1-20.
Prog. Polym. Sci. 2015, 51, 28-73.

PPG 2030 sustainability targets with 2019 baseline

validated science-based targets

50%⬇

reduction in absolute scope 1 and 2 greenhouse gas (GHG) emissions



30%⬇

reduction in absolute scope 3 GHG emissions

100%

reuse, recycle or recover 100% of process waste

25%⬇

reduction in waste intensity

5%⬇

annual reduction in spill release rate

15%⬇

reduction in water intensity at priority sites

50%

sales from sustainably advantaged products

100%

of key suppliers assessed against sustainability and social responsibility standards

100%

of employees go home safely each day

$15MM

Commitment to COLORFUL COMMUNITIES® projects globally, with all projects having an element of sustainability

Research and Development Process

Innovation lab-high throughput tests

1Ft columns

Development lab – scale up tests

8Ft columns

Country Dependent

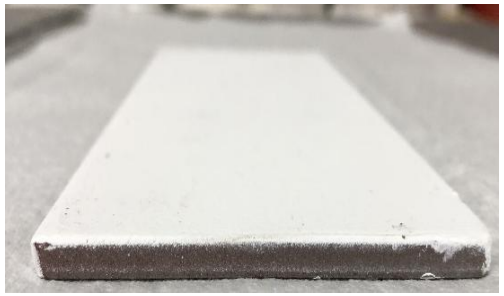
- Cellulosic fires
  - ISO 834
  - UL 263
- HC Pool fire
  - UL 1709
- HC Jet fire
  - ISO 22899-Part 1 & Part 3

- **From ideation → commercialization**
- **Several other tests in addition: Take significant time and third-party tests**

Need for Accelerated Tests

1 FOOT I-BEAM

FIELD APPLICATION



4X6 PANELS

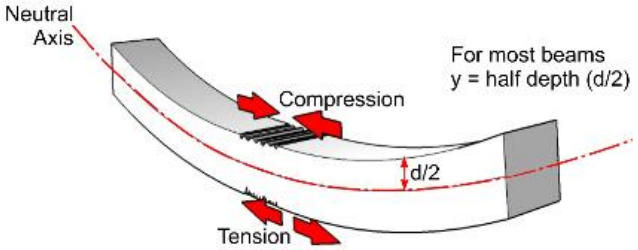
NORSOK…

- Convection Oven
- Cone Calorimetry
- Bunsen Burners
- …Fast & Reliable!

Reliable accelerated tests are key for innovations

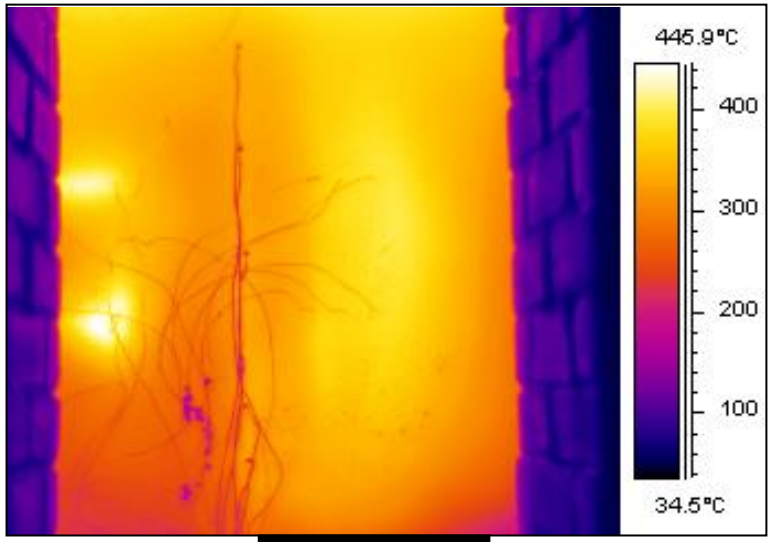
Understanding the Need for Flexible PFP

Steel under operational loads



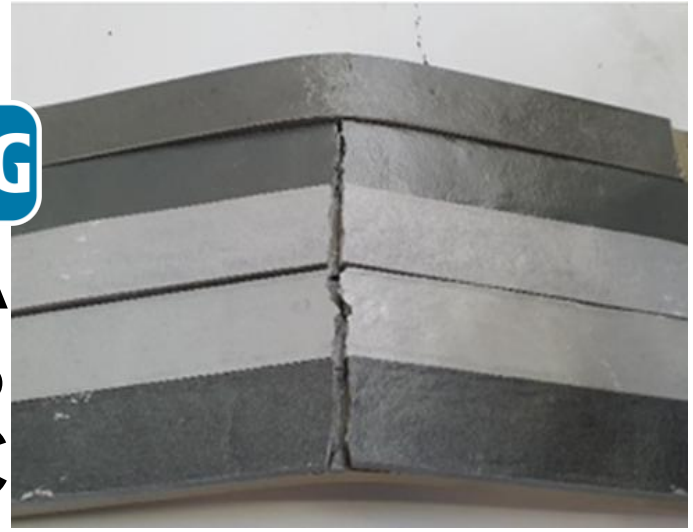
Exposed to very low temperatures

Does it impact fire performance?



- With cracks/delamination: 60 min to 433 °C
- Without cracks/delamination 60 min 388 °C

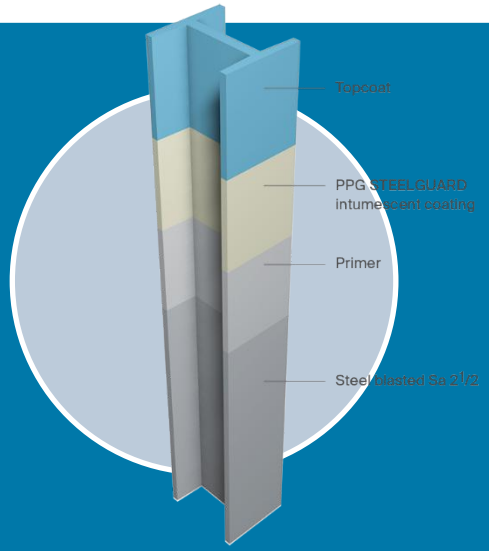
A
B
C



* Acceptance Criteria for Damaged Passive Fire Protection Coatings - Simon Thurlbeck, MMI Engineering - FABIG Technical Meeting 57, 2009

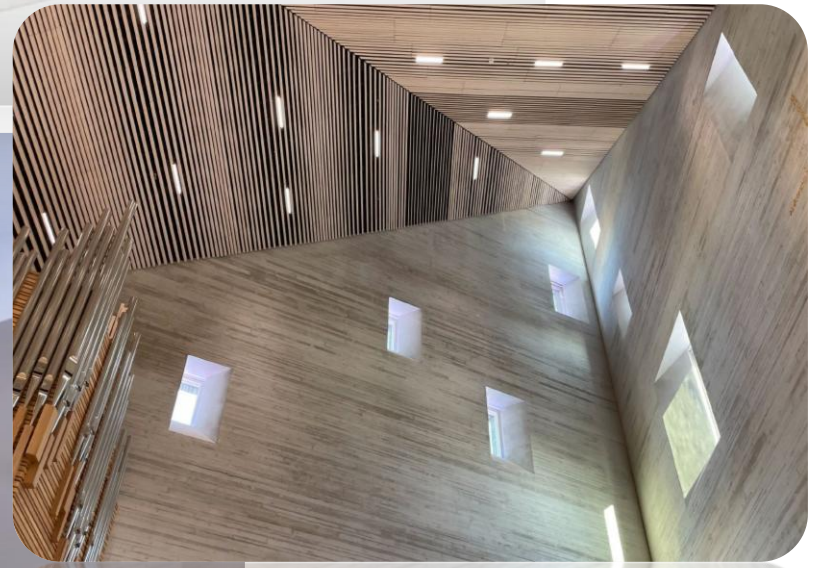
Reliable accelerated tests are key for innovation/differentiation

PFP Drivers – Future Trends



Aesthetics / Durability
Ease of Application
Sustainability
Regulatory
Hybrid Solutions
Compact Systems

Market & Technology Trends



https://www.youtube.com/watch?v=FJdkJcSEoBw

Let’s Create Value!

- PFP coatings are one of the fastest growing segments
- Innovation opportunities: new polymers, substances of concern, new applications
- Join us!

- **Passive Fire Protection Coatings protect and beautify**
- **Protect investments, reduce downtime**

Thank You

Questions?

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We protect and beautify the world™