



SOLVAY

asking more from chemistry®

ThermoPlastic Composites (TPC) at Solvay

November 12, 2019

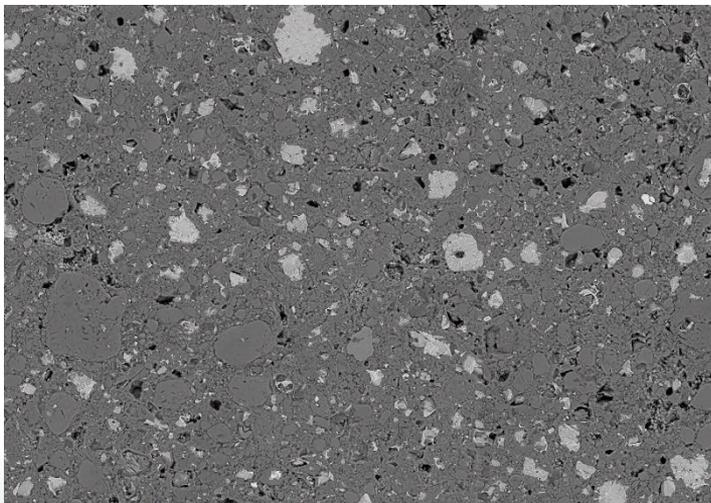
Nicolas Cudré-Mauroux

WHAT IS A "COMPOSITE"?

An heterogeneous mixture of (at least) 2 materials:

- a **MATRIX**
- a **REINFORCEMENT**

E.g. concrete: cement + stones



WHAT IS A "COMPOSITE"?

Wood: cellulose + hemicellulose (+ lignine):

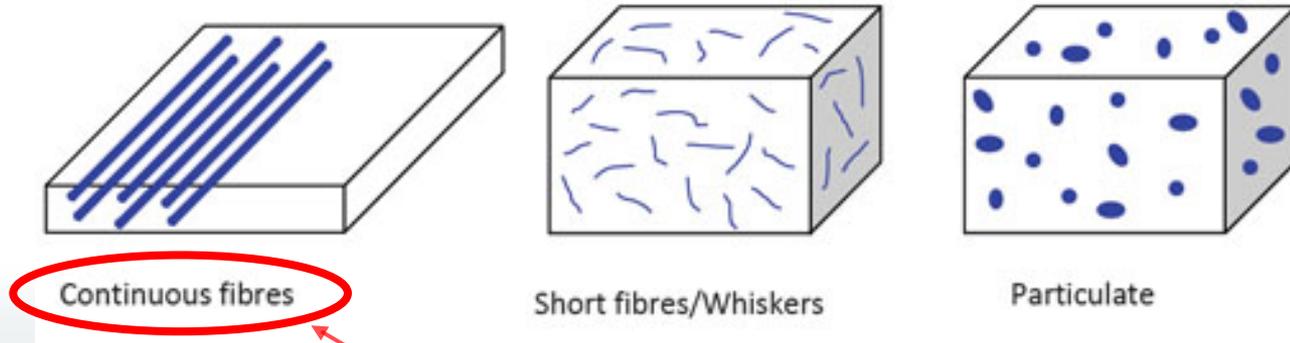


OUR COMPOSITE MATERIALS

In Solvay, matrices we work with are **POLYMERS** (not metals or ceramics).

Our polymers can be either **THERMOSET** or **THERMOPLASTIC**.

We use 3 main types of reinforcements:



Continuous fibres

Short fibres/Whiskers

Particulate

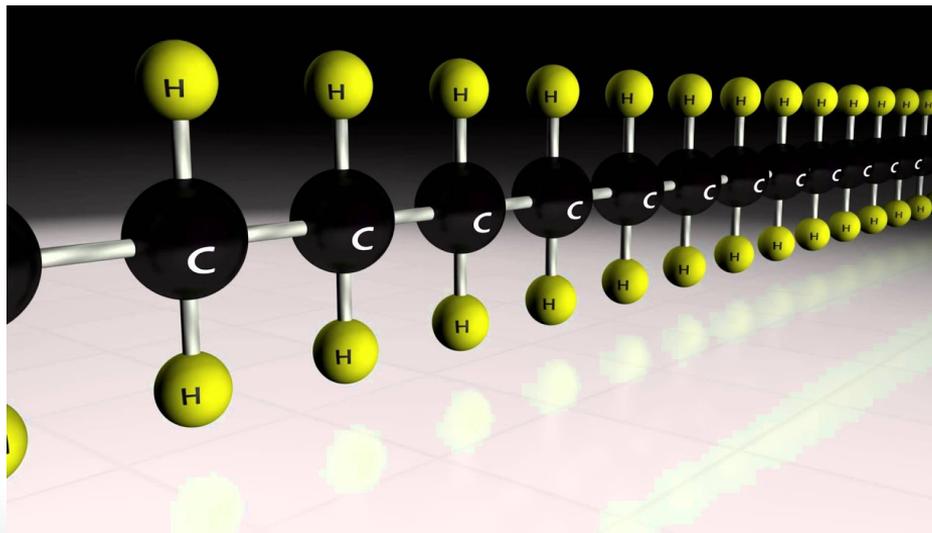
Our focus for today

WHAT IS A "POLYMER"?

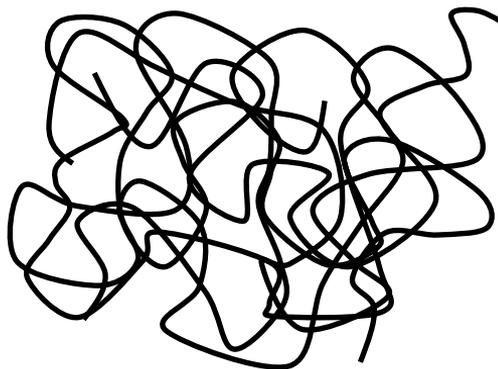
Macromolecule made of multiple repeating units (monomers)

For example, the simplest one:

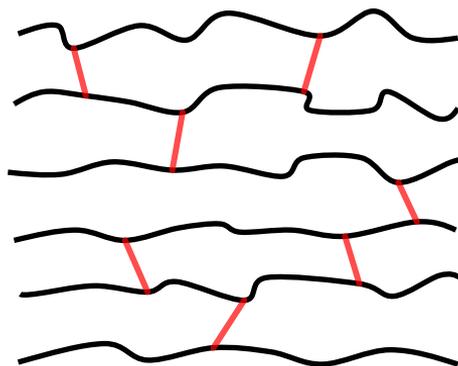
Poly-ethylene
[C-C]_n



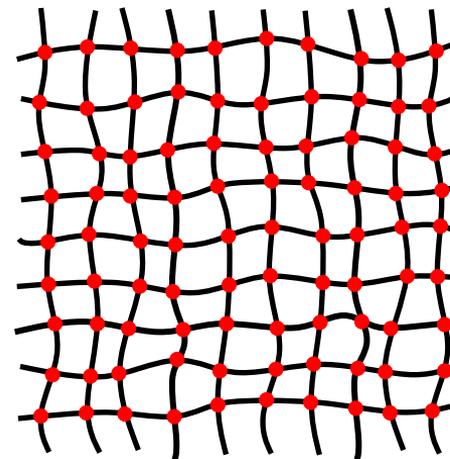
THREE TYPES OF POLYMERS



Thermoplastic



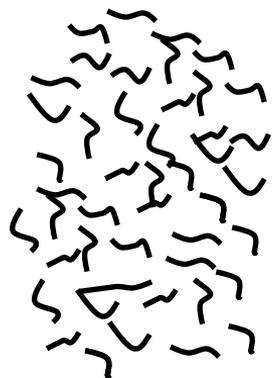
Elastomer



Thermoset

TWO TYPES OF PROCESSING

1) THERMOSET

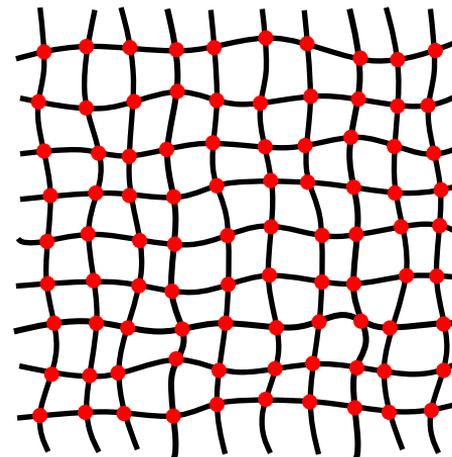


+

2 liquids



Chemical reaction
(non reversible)

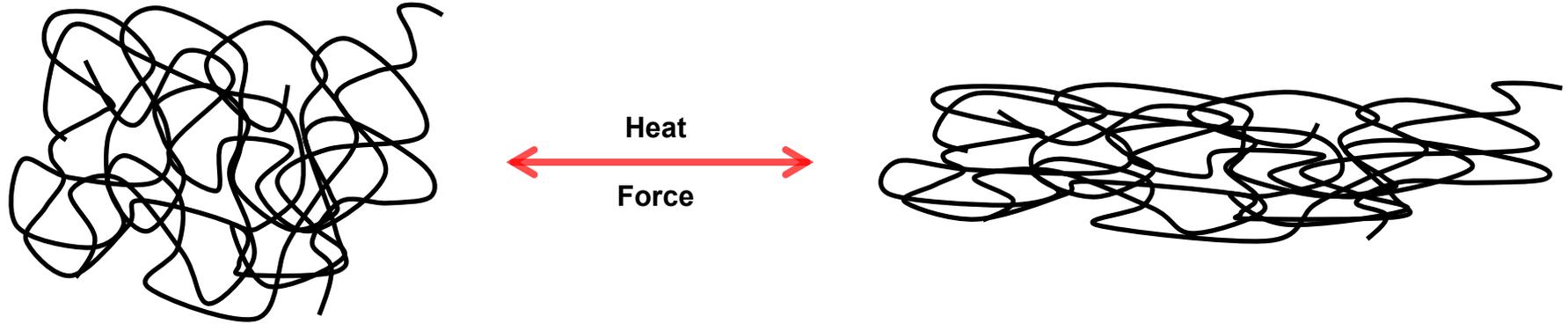


1 solid

E.g. epoxy or phenolic resins used today by our Composites GBU

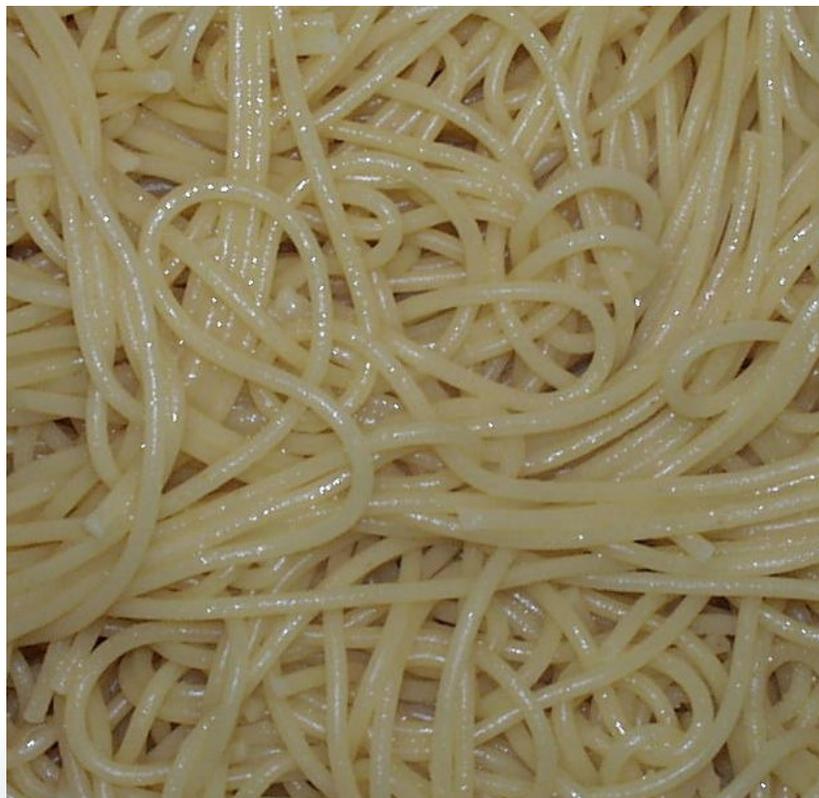
TWO TYPES OF PROCESSING

2) THERMOPLASTIC

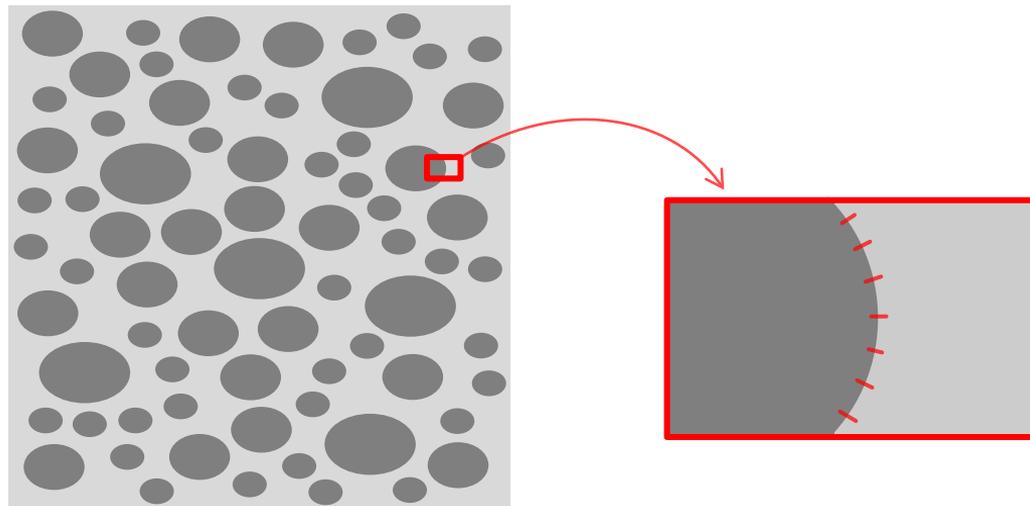


**No chemical reaction
(reversible transformation)**

LOOKING INSIDE A THERMOPLASTIC POLYMER



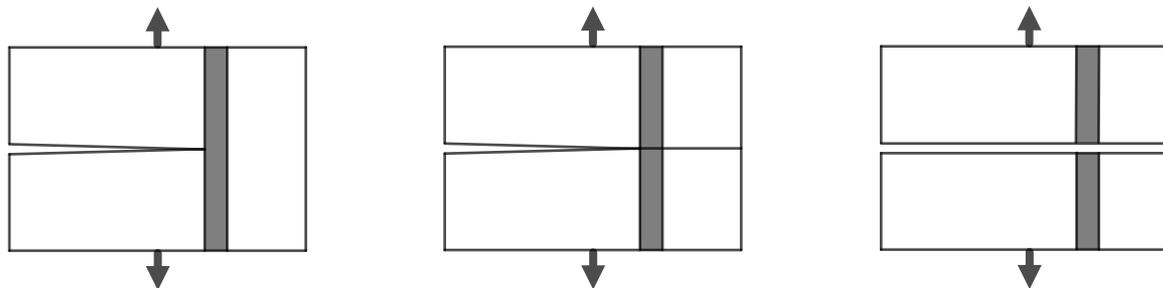
THE SECRET INGREDIENT THE INTERFACE



Optimizing the interface is critical to optimize properties of composite materials

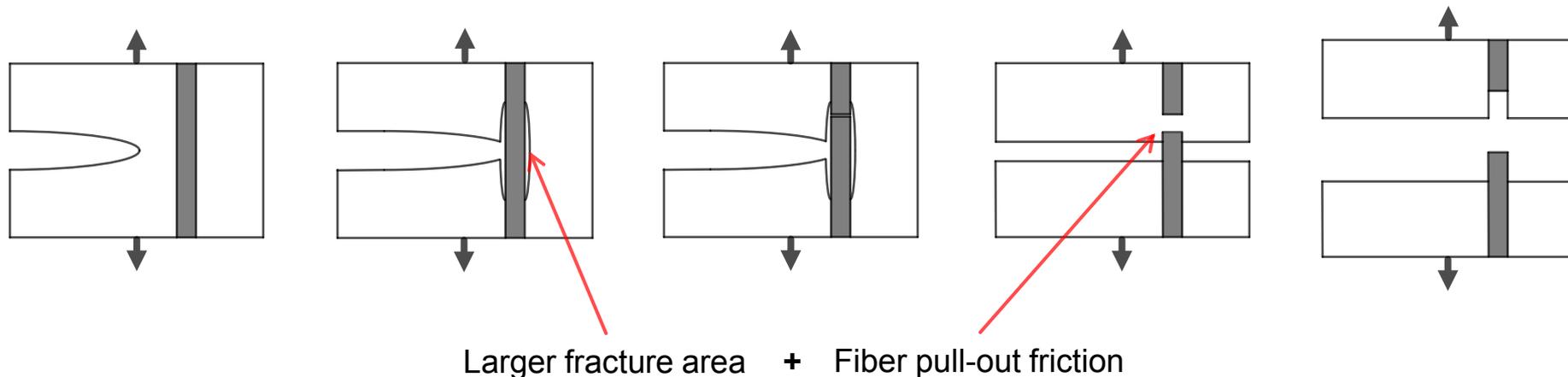
... and we have a lot of competencies in this area!

"Perfect" (i.e. strong) adhesion:



The crack barely "sees" the fiber \Rightarrow rigid but brittle composite

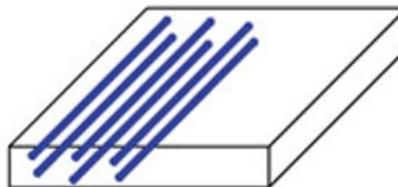
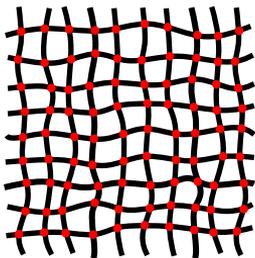
Optimized adhesion:



⇒ **MORE ENERGY CONSUMED BY THE FRACTURE PROCESS**

THERMOSET AND THERMOPLASTIC COMPOSITES

THERMOSET:

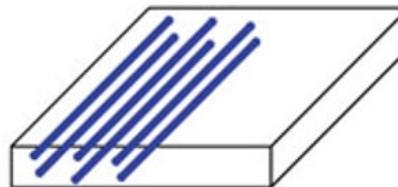
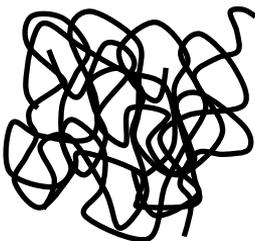


Continuous fibres

Great properties but ...

- Long processing time (chemical reaction)
- Very hard to recycle

THERMOPLASTIC:



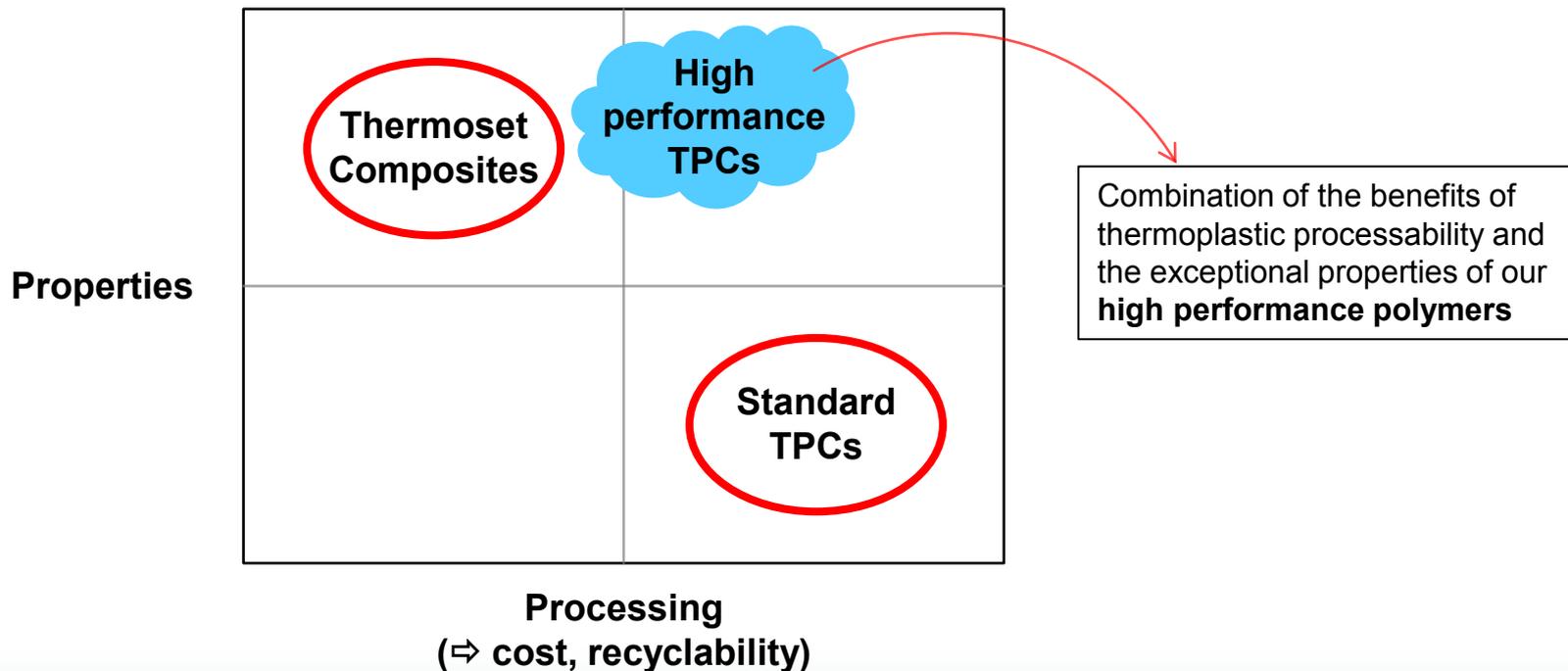
Continuous fibres

Less rigid matrices but ...

- High productivity processes
- Recyclability

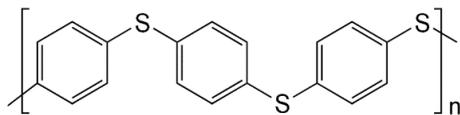
Both are complementary and address different applications

THERMOSET AND THERMOPLASTIC COMPOSITES

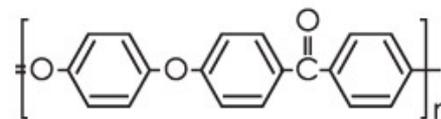


WHAT IS SPECIAL ABOUT OUR **HIGH PERFORMANCE** THERMOPLASTIC POLYMERS?

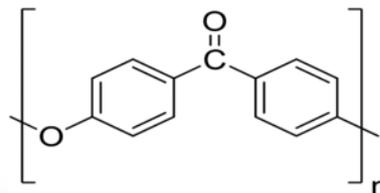
In our high performance polymers, we eliminate weak chemical bonds to make them mechanically strong and highly resistant to heat and chemically aggressive environments



PPS



PEEK



PAEK

Questions?

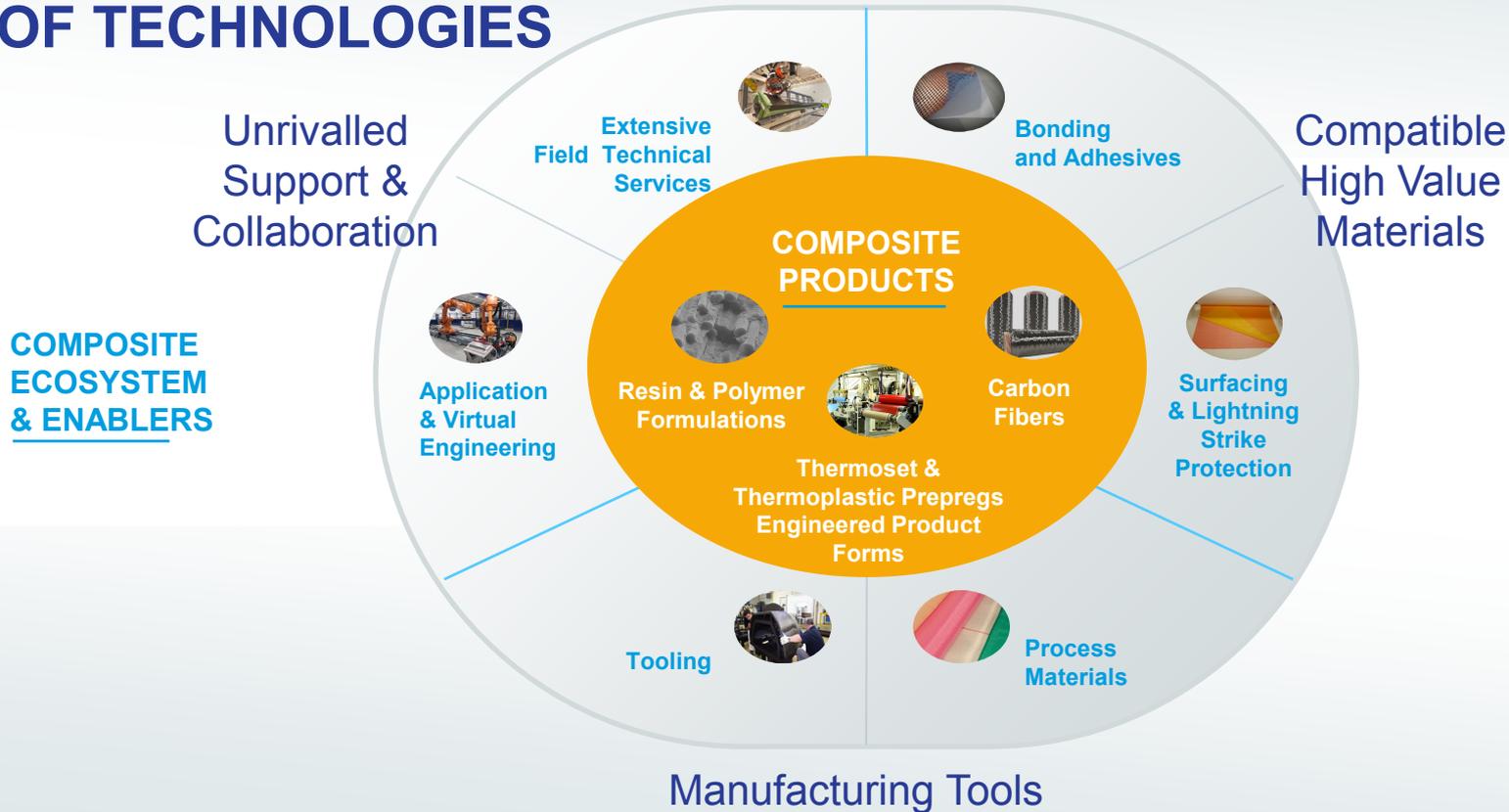


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FOLLOW US ON



UNMATCHED PORTFOLIO OF TECHNOLOGIES



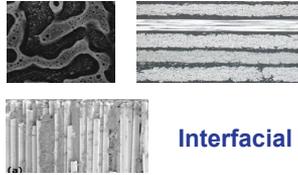
COMPOSITE MATERIALS RESEARCH & INNOVATION

Multidisciplinary & Multi-scale

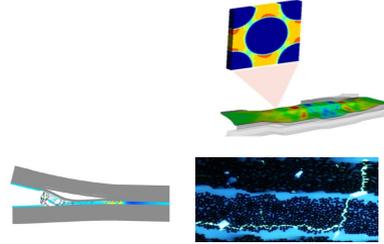
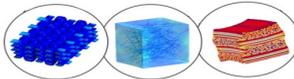
'Atoms to Airplanes'



Formulation Chemistry
Polymer Science
Fiber Science

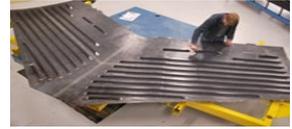
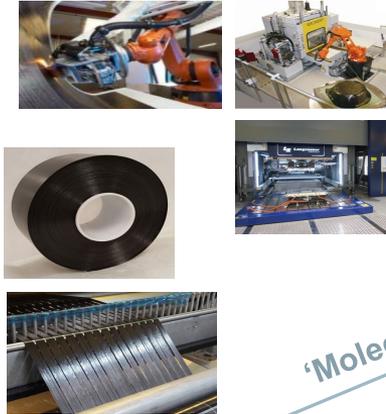


Interfacial Properties
Composite Toughening
Product Architecture
Processing Science
Product Forms



Fracture and Failure Analysis

Manufacturing R&D



Structures

Application Engineering



'Molecules to Vehicles'

APPLICATIONS - Aerospace

Reaching new heights with composites

Interiors

FST composites
Adhesives
Thermoplastic films and resins

Empennage

Composites
Adhesives
Radji filler

Engines

High service temp composites
Impact resistant resins
Sealants and adhesives

Fuselage

Damage tolerant composites
Bonding primers
Surfacing films
Adhesives

Manufacturing Enablers

Composite tooling
Process materials
Ancillaries

Wing

Composites
Liquid resin infusion
Tailored textiles and preforms
OoA prepregs
Lightning strike protection

APPLICATIONS – Oil and Gas

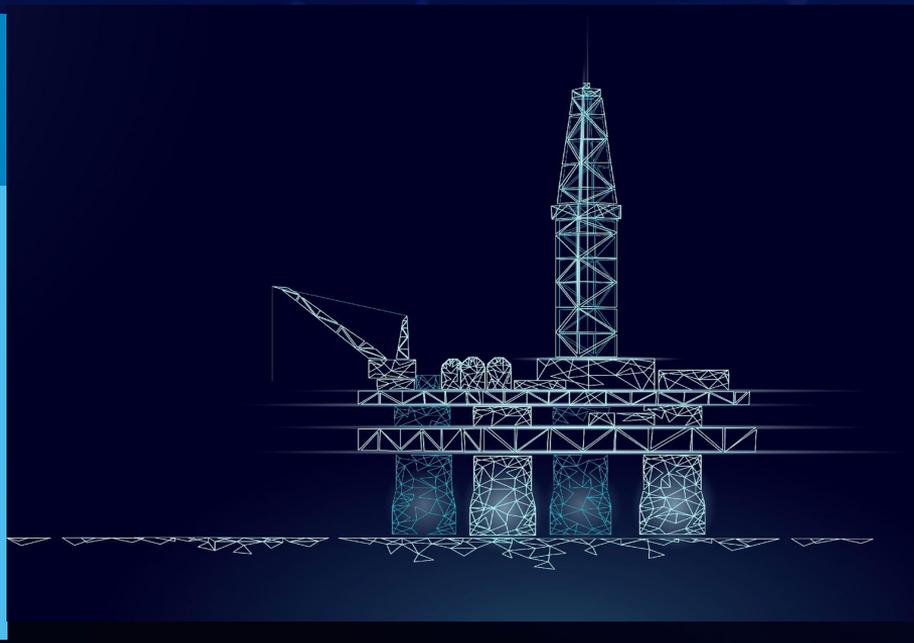
Composite materials that go deeper and further

MATERIALS

Lightweight thermoplastic composites
Evolite F1050 PVDF Carbon Fiber prepreg.

BENEFITS THAT COMPOSITES BRING

- Weight reduction
- Resistant to corrosion
- High fatigue performance
- Design optimization
- Enables lower total installed costs
- Enables access to ultra-deep water



APPLICATIONS - Automotive

Driving the world towards a more sustainable future

Closures: hood, trunklid, doors

Design freedom
Class A finish
Meet crash and safety performance

Secondary structures / Battery tray: transmission tunnel, leafspring, spoilers, diffusers, wings, seats

Stiffness and impact performance
High energy absorption levels
Noise and vibration reduction

Body in White: Pillars, bulkheads, floor pan, body side, roof rails, door sill

Meet crash and safety performance
Structural integration
More flexible around vehicle architecture

Trim: Dashboard, door inner, rocker panel

Stiffness and impact performance
Fatigue performance
Design freedom

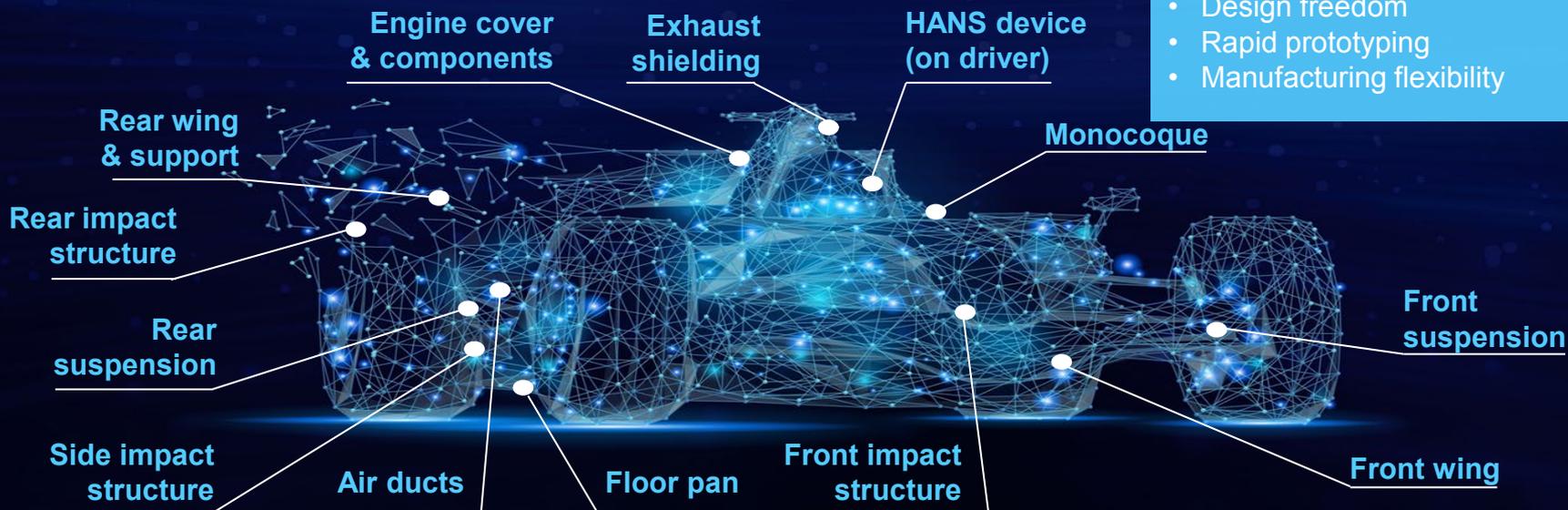


APPLICATIONS - Motorsport

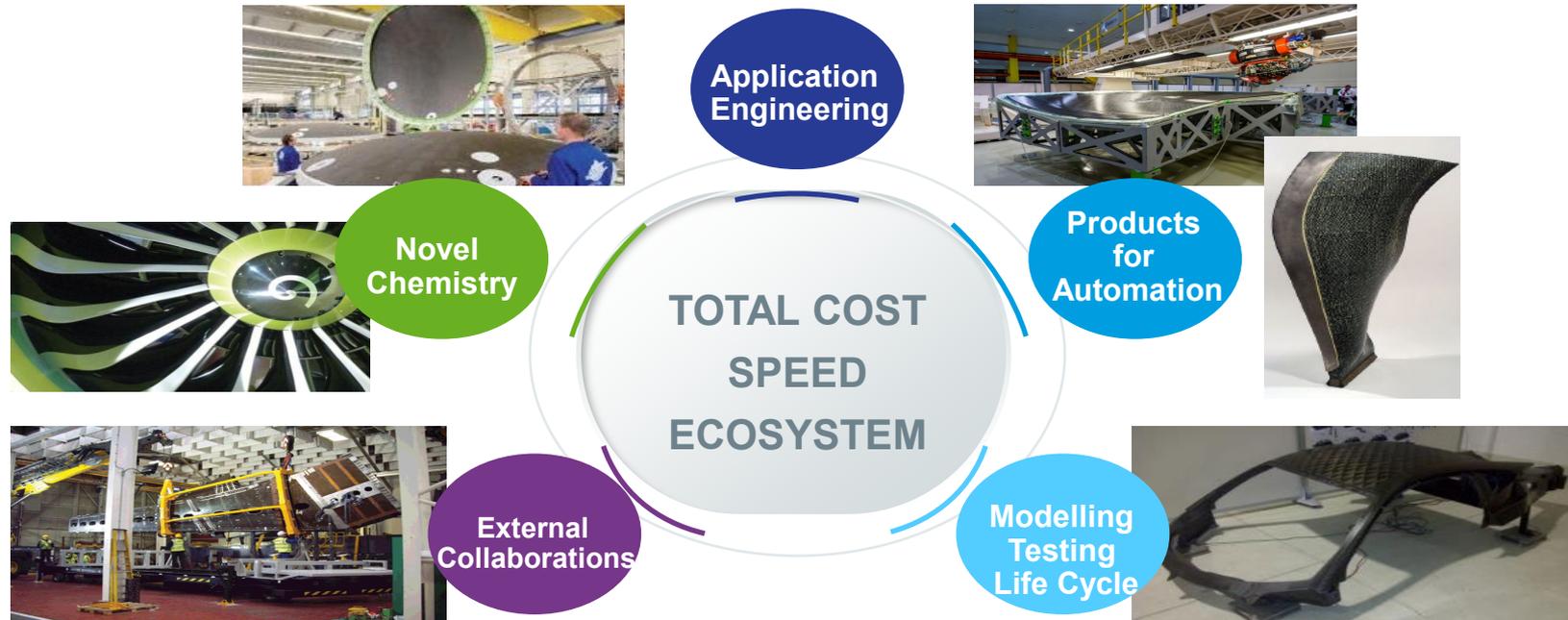
Composite materials that help boost performance

Up to 75% of race cars are composites.

- Stiffness
- Lightweight
- Impact strength
- Energy absorption
- Temperature resistance
- Strength
- Design freedom
- Rapid prototyping
- Manufacturing flexibility



HOW DO WE ANTICIPATE AND DEVELOP SOLUTIONS



More than a material supplier we are a technology integrator

TO GROW FURTHER, COMPOSITES MUST DELIVER MORE VALUE

Beyond lightweighting,
composites bring additional benefits:

- Aerodynamics
- Fatigue life
- Corrosion resistance
- Design freedom
- Part integration
- Function integration
- Increased passenger comfort



**CHALLENGES
FOR THE FUTURE**

**MANUFACTURING
TECHNOLOGIES**

JOINING

SIMULATION

WHY DO WE HAVE THE "RIGHT TO WIN" IN TPC?

Best portfolio of high performance thermoplastic polymers



Differentiated properties for high value-in-use applications

Strong presence in composites and carbon fibers



Ability to adapt fibers and access to composite experts

Core competencies in surface and interface engineering



Unique solutions protected by strong IP

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