Introduction on Composite materials

Thierry Le Hénaff
CEO Arkema

23 & 24 June 2015

Composites: a growing industry dominated by Fiber Reinforced Plastics

Composites are materials made from reinforcing fibers/particles and a binding matrix

Metallic matrix Composites

Market value **$ 0.3 billion**
CAGR 2014-2020 **7%**

Cylinder sleeves in the engine block of the Porsche Boxster

Ceramic matrix Composites

Market value **$ 1.3 billion**
CAGR 2014-2020 **14%**

Engine exhaust cone for jet engines

Organic matrix Composites
(or Fiber Reinforced Plastics)

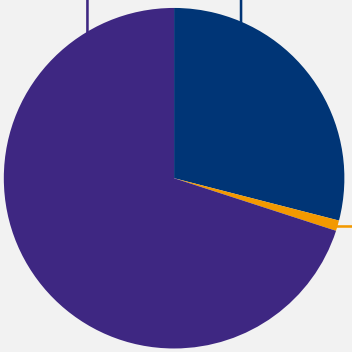
Market value **$ 38.3 billion**
CAGR 2014-2020 **7%**

Wind mill blades and nacelle covers

ARKEMA INNOVATIVE CHEMISTRY

Organic matrix composites are split between thermosets and thermoplastics (TP)

Global market



Thermosets

Mainly liquid resins
with continuous fiber
(higher performance)

TP

Solid resins
with non-continuous fiber
(non-structural)

CFR-TP 0.2%

Continuous-Fiber
Reinforced
Thermoplastics

100% = ~4 million tons (resin)

Higher performance than short fiber TP

Benefits vs. thermosets

- **Recyclable**
- **Assembly by welding**
- **Higher productivity**

ARKEMA INNOVATIVE CHEMISTRY

Fiber Reinforced Plastics growth is driven by metal substitution

1

Lightweight & energy savings

2

Corrosion resistance & enhanced lifetime

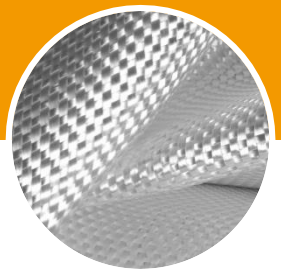
3

Design freedom for large and complex parts

ARKEMA INNOVATIVE CHEMISTRY

However, composite growth is slow-downed by several challenges to overcome

Composite life cycle	Design and properties	Raw materials	Composite part production	Use and End of life
Challenges to solve for a wider use of Composite materials	Know-how to design and predict properties Improved mechanical properties (fatigue, impact, thermal…)	Matrix and fibers with optimized cost-performance balance (low cost carbon fibers, new resins)	Productivity and assembly Lower cost manufacturing (higher automation)	Dismantling and Recycling



ARKEMA INNOVATIVE CHEMISTRY

Thermoplastic composites can meet these challenges to accelerate composite growth

Composite life cycle	Design and properties	Raw materials	Composite part production	Use and End of life
Benefits from Thermoplastic Composites	Improved fatigue and impact properties	More diversity of polymers 15 thermoplastic vs. 5 thermoset polymer families	Higher productivity (1-2 minutes vs. 3-60 minutes for thermosets and 1 minute for metal) New assembly opportunity (welding)	Recycling by melting (similar concept than metal recycling)

Thermoplastic Composites are still considered as "young" materials, which are developed since the end of the 80's, and should reach maturity within the 10 next years

ARKEMA INNOVATIVE CHEMISTRY

Thermoplastic composite application example: Aerospace

KEPSTAN™ BY ARKEMA

- Process cost reduced by 40%
- Production rate x2 *vs.* thermosets
- Recyclable
- Fire resistant

ARKEMA INNOVATIVE CHEMISTRY

Thermoplastic composite application example: Automotive

RILSAN® HT
BY ARKEMA

- 40-50% weight reduction vs. steel
- 100 kg saving = 9 gCO_2 /km reduction
- Recyclable
- Corrosion free

ARKEMA
INNOVATIVE CHEMISTRY

Thermoplastic composite application example:
Sport & Leisure

PEBAX® BY ARKEMA

- 30% increase in vibration damping
- Recyclable
- Better impact properties

ARKEMA INNOVATIVE CHEMISTRY

Thermoplastic composite application example:
Wind energy

ELIUM® BY ARKEMA

- Lower manufacturing cost *vs.* epoxy
- Promising fatigue properties
- Recyclable
- No process change

ARKEMA INNOVATIVE CHEMISTRY

Thermoplastic composite application example: Defense

POLYSTRAND® VIA ARKEMA

- Lightweight
- High energy absorption properties
- Blast resistance
- Low maintenance cost

ARKEMA INNOVATIVE CHEMISTRY

Outlook

The annual world production of each of the **Top 4 materials**

Concrete	10 billion tons/y.
Wood	2 billion tons/y.
Steel	1.7 billion tons/y.
Glass	0.1 billion tons/y.

All are recyclable or renewable

Composites have a world production around 10 million tons per year.

The key question:
will easiness of thermoplastics transformation and their recyclability allow them to enter in the category of "Top materials" ?

ARKEMA INNOVATIVE CHEMISTRY