WORLD MATERIALS FORUM

Substitutive and alternative materials for competitiveness

Prof. Victoire de Margerie

Initial hypothesis of all 3 sessions

Material breakthroughs

- Materials breakthroughs should be used to change the paradigm from **"either or"** to **"and and“**
- **Accelerating research** is a crucial need and this can be achieved thanks to quantum simulation, bridging between industrial sectors and building interdisciplinary teams

Composites

- **Plastic reinforced composites** are the biggest and fastest growing market within composites
- **Future generation composites as well as use of technologies** from other sectors will support further growth - reduction of manufacturing costs, industrialization of recycling, incorporation of extended functionalities - Internet of Things

Continuous Competitiveness

- The need is **to improve the value proposition for customers** (making it "more green" but also "higher quality" and "lower cost") and to **increase the competitiveness** of companies providing the related products/services
- This can be achieved thanks to **optimizing materials composition, parts design and overall process manufacturing efficiency** from the start

Session 1 – Why we need to accelerate research?

	Now → 2025	
Access to middle class	from 2.5 to 4.2 billion people	▪ More packaging ▪ More cars
Urbanization	from 54 to 58%	▪ More waste ▪ More vertical housing
Internet access	from 3 to 5-6 billion people	▪ More energy consumption ▪ More mobility

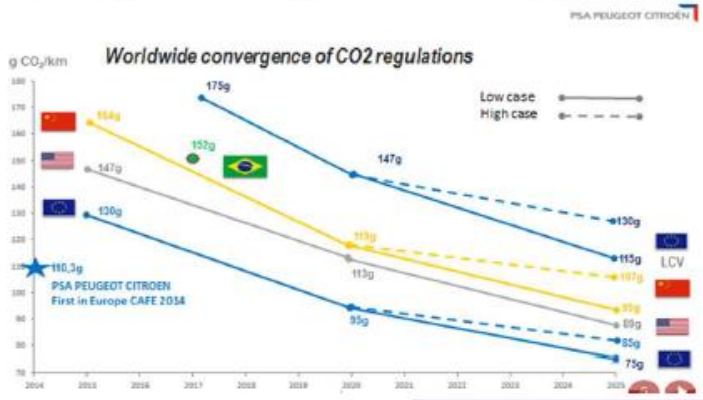
Increased pressure on materials industry to react quickly

PSA – Materials breakthroughs for 2050

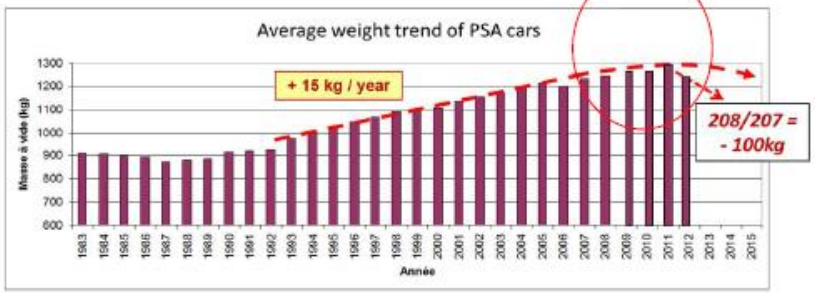
CO2 emission reduction & Safety improvement through weight saving

PSA PEUGEOT CITROËN

308 II vs 308 I



Paradigm has changed in the 2010's



WMF - 2015 june 23th

-140kg
-20% CO2
5* EuroNcap

Several lightweight solutions

- 4 kg saved with hybrid tailgate

- 4,5 kg saved with very high strength steels

- 3 kg saved with composite floor

EPFL – An industrial age for materials simulations

MATERIALS' DEVELOPMENT: INTUITION, SEARCHES, AND SERENDIPITY

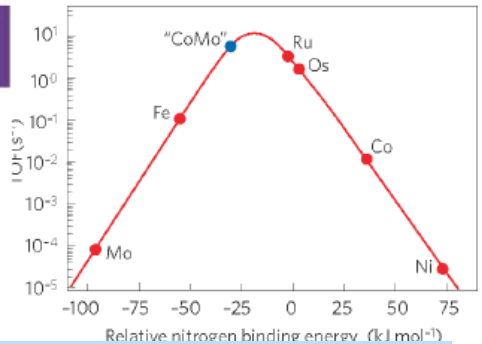
Simulation allows us to predict properties

- Edison tested 3000 materials for his filament – settling on burned sewing thread.
- Haber–Bosch ammonia synthesis used osmium as catalyst. Mittasch (BASF) tested more than 22,000 materials to identify the iron-based catalyst which is still used today.
- Norskov showed in 2009 that CoMo is a more efficient inexpensive catalyst.

nature chemistry
REVIEW ARTICLE
PUBLISHED ONLINE: 19 MARCH 2009 | DOI: 10.1038/NCHEM.121

Towards the computational design of solid catalysts

J. K. Nørskov[1]*, T. Bligaard[1], J. Rossmeisl[1] and C. H. Christensen[2]



We still need testing for durability, aging and integration

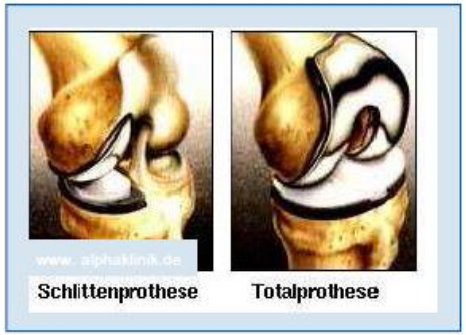
ITV – Interdisciplinary development of biomaterials for tissue regeneration

Regenerative Medicine

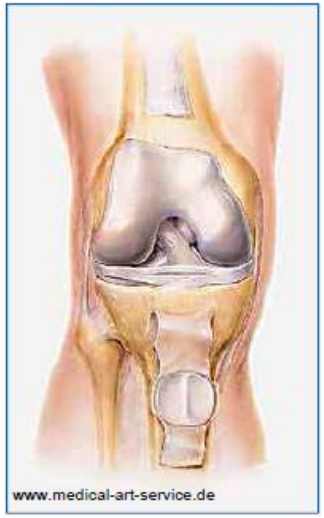
Example: Defect of the knee / cartilage

Paradigm today:
Replacement

Spare Parts (e.g. Metals)



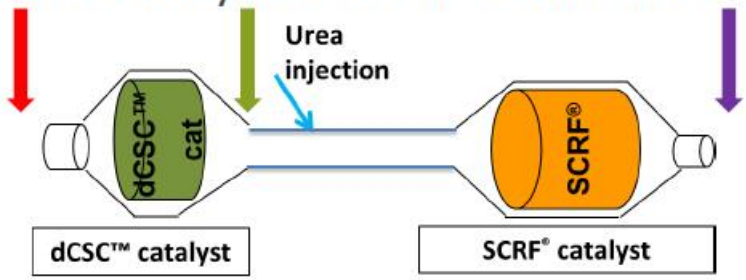
Future Paradigm:
Regeneration
of Cartilage with
Biomaterials,
Cytokines
(Cells)

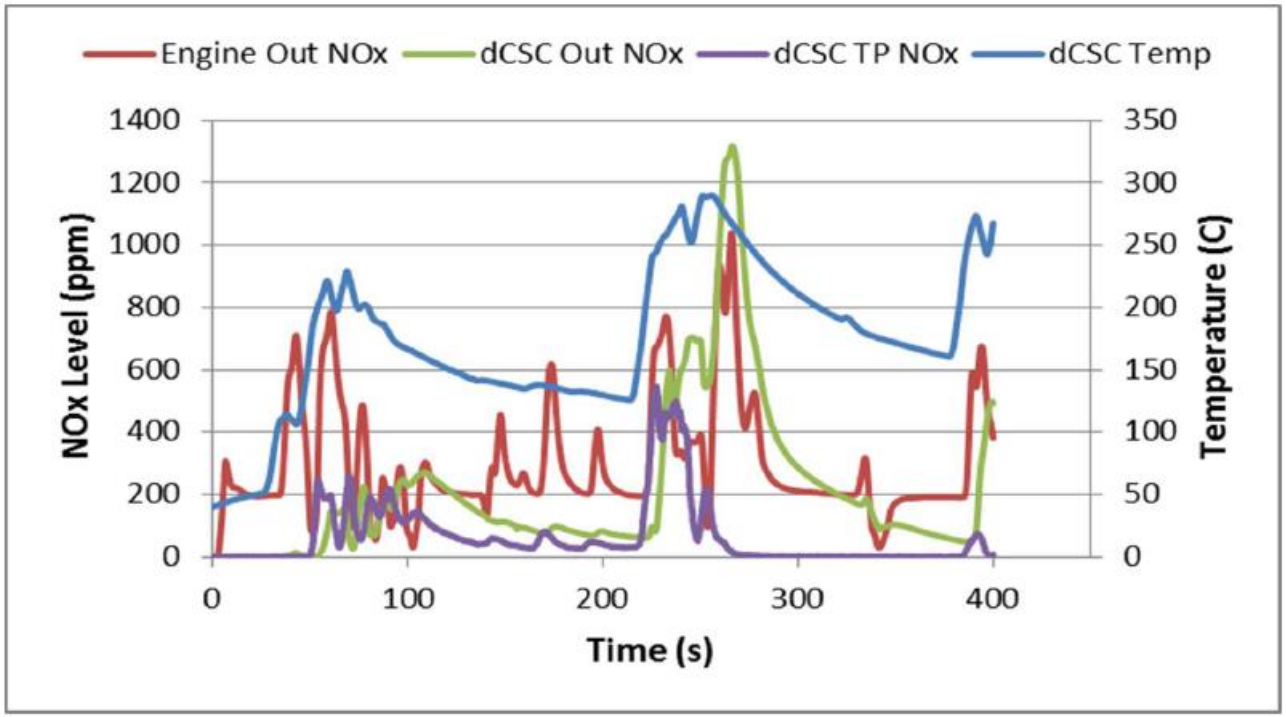


Johnson Matthey – Application of nanostructured porous materials

Johnson Matthey

Pd-zeolites in automotive catalysts enables cold-start NOx emission control





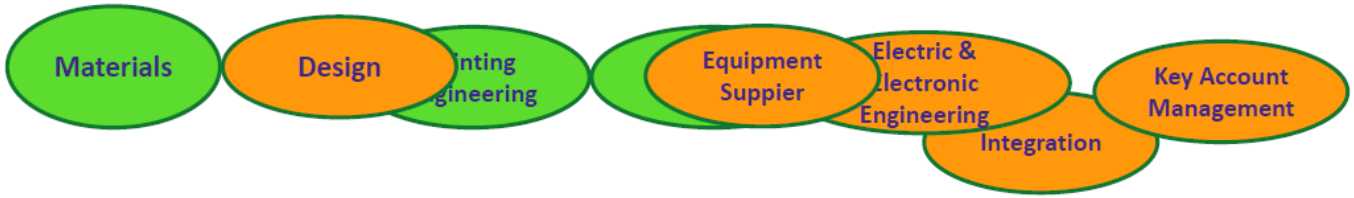
Piezotech – Electroactive polymers for new applications

Key Challenges

New Materials for New Applications using New Technologies …

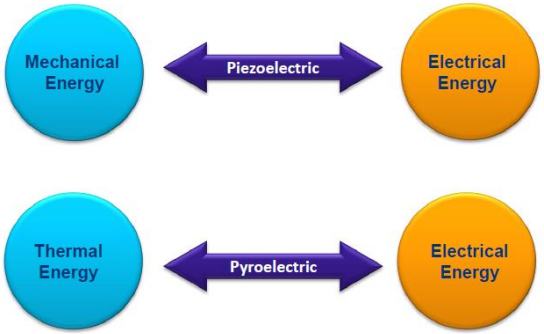
Building a supply chain

Materials | Printed Demonstrators | Pilot Printed Electronic Line | Electronic PE lines | OEM | End Users



Gathering expertize

Fluorinated Electroactive Polymers



PIEZOTECH ARKEMA GROUP

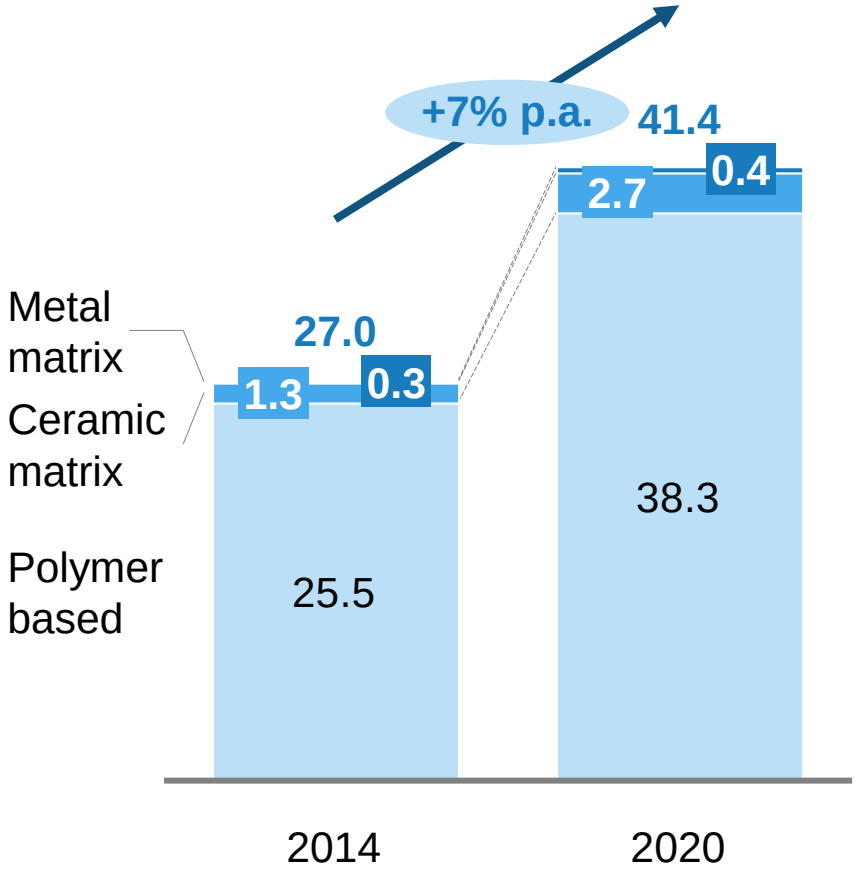
Sensors, Actuators & Memories

WORLD MATERIALS FORUM

Session 2 – Plastic reinforced composites are the biggest and fastest growing market within composites

Global composite market by type

USD billion



Growth drivers

- Lightweight
- Energy savings
- Corrosion resistance
- Freedom of design

Challenges

- Improved fatigue resistance
- High cost of materials
- Manufacturing equipment constrains
- Recycling issues

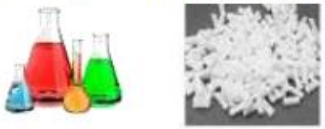
Integrated Engineering Development Process (IEDP)

❑ Materials

TS and TS;
Glass, Carbon & Aramid;
Material properties;
Material cost, processibility

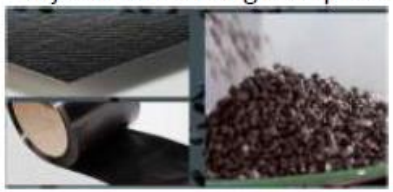
- Fibers (carbon, glass, aramid)

- Thermoset & Thermoplastics



- Non-Crimp or woven Fabrics

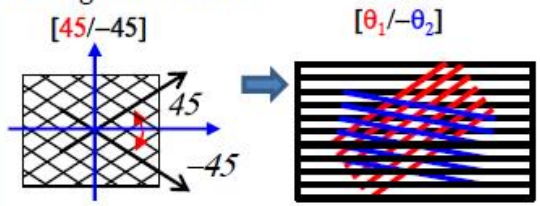
- resin pre-preg products & Injection-molding compounds



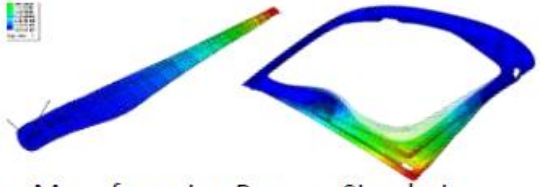
❑ DESIGN

Design for easy process;
Optimal Fiber direction;
Optimal performance and process

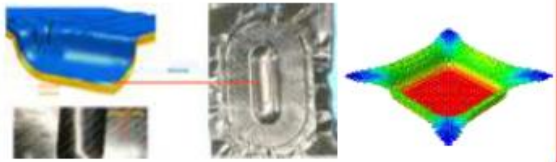
- Design Innovation



- Design from Structure Simulation
  - Stiffness, strength, buckling, vibration, fatigue



- Manufacturing Process Simulation



❑ Manufacturing Process

Hybrid Process for cost-effective (high cycle rate) process and better mechanical performance

- Mold and Tool Selection

- Manufacturing Process
  - Compression
  - Injection
  - RTM,
  - RIM,
  - C-RTM,
  - HP-RTM,
  - T-RTM

Session 2 – Examples of composite achievements

New functionalities

ARKEMA

Pultrusion process with more than 70% fiber content -> Hyundai front bumper 3.5 kg less vs steel at the same performance (JEC award 2015)

NIKE

Benefiting from thermoplastic composite flexural fatigue, durability specific gravity, and overmold adhesion in soccer and running shoes

Cost reduction

AIRBUS

Lower cost of technology development through:

- Conducting less tests
- Introducing new building blocks

Morgan Advanced Materials

Applied the gained experience in computer modelling to other commercial applications such as impact structures for satellites and rail

More green

ARKEMA

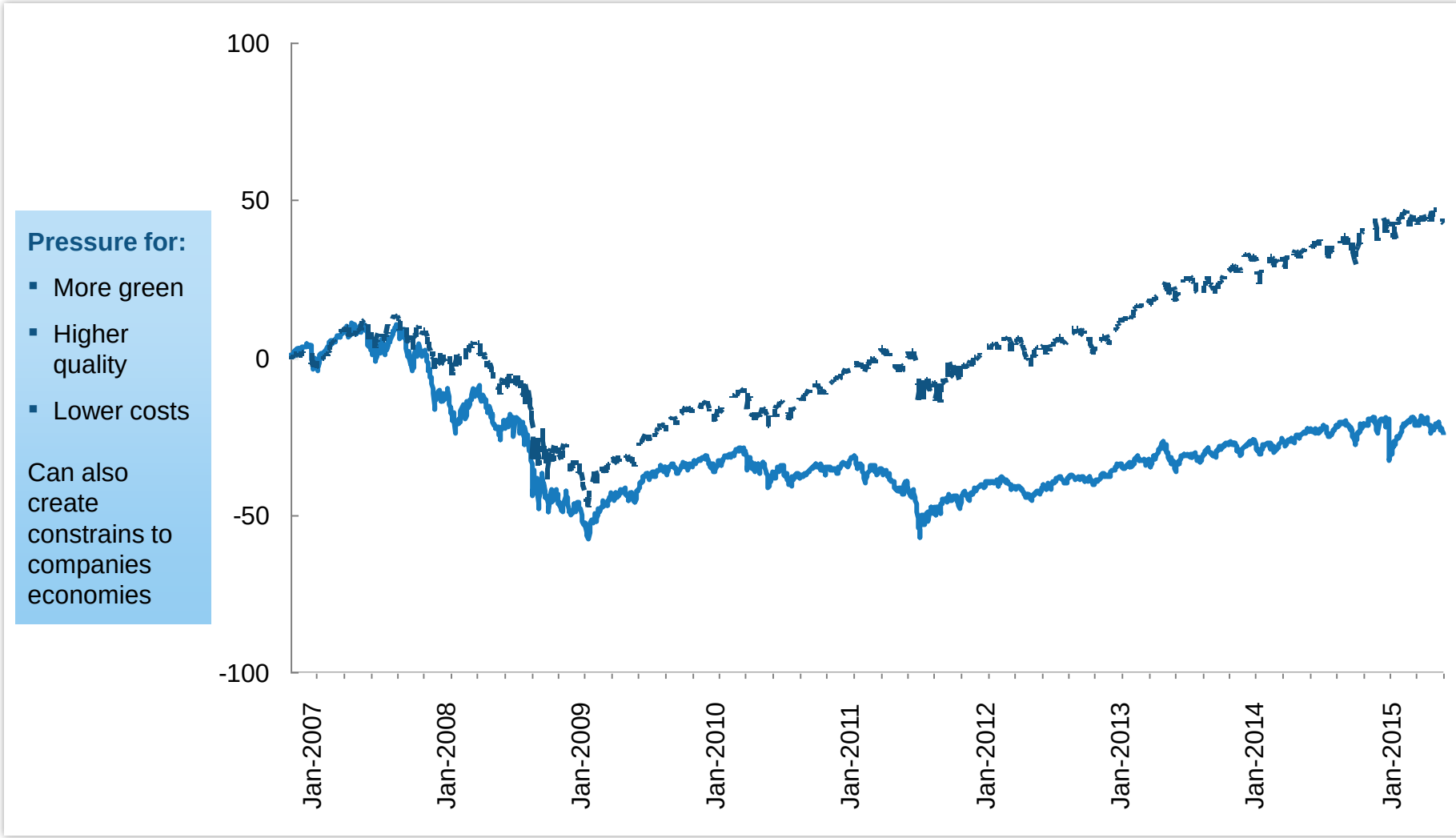
Thermoplastic composites easier to recycle

HANYANG UNIVERSITY

Integrated Engineering Development Process is effective in developing composite parts with optimized cost and performance

Session 3 – Why is it urgent to react to pressure and be continuously competitive and sustainable?

Percent



Pressure for:

- More green
- Higher quality
- Lower costs

Can also create constrains to companies economies

SOURCE: Capital IQ

UCIrvine – Internet of Things – improving productivity and sustainability

UCIrvine | The Paul Merage School of Business

Example – Blast Furnace Remote Monitoring and Diagnostic System (BFRMDS)

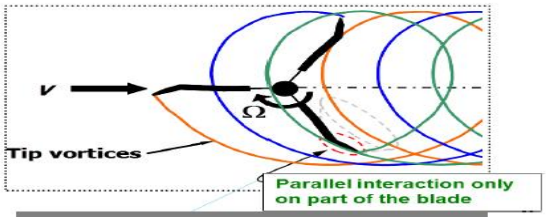
ArcelorMittal

- Real-time remote monitoring of blast-furnace parameters
- Piloted in 2010 and now operational at 10 furnaces (6 planned for 2012)
- Tracks 500+ performance data points and 30+ KPIs per furnace
- Facilitates early detection of process problems
- Enables global process experts to collaborate in real time
- Identifies the most appropriate action at the right time
- Facilitates sharing of best practices
- Supports development of a universal knowledge-base
- Estimated $20 million annual savings (plus avoidance of catastrophic events)
- Approach now being developed for electric-furnace operations

Airbus Helicopter - Multi skilled R&D for new materials/ processes

Innovation and disruptive ideas - need smart organizations

Example Blue Edge ™



Concept

Prototype

Product

Fuel consumption reduction 15 to 20%
Acoustic footprint reduced by half

AIRBUS HELICOPTERS MATERIALS FORUM

Rondol - Cross Industries Technology Transfer

Extrusion for food

- Longer barrel
- Cooler barrel
- CO_2 injection

Extrusion for Pharma applications

- Chaotic mixing screws
- Multi-skilled team:
- EMR, Arkema-Rondol, Greenwhich and Stuttgart Universities

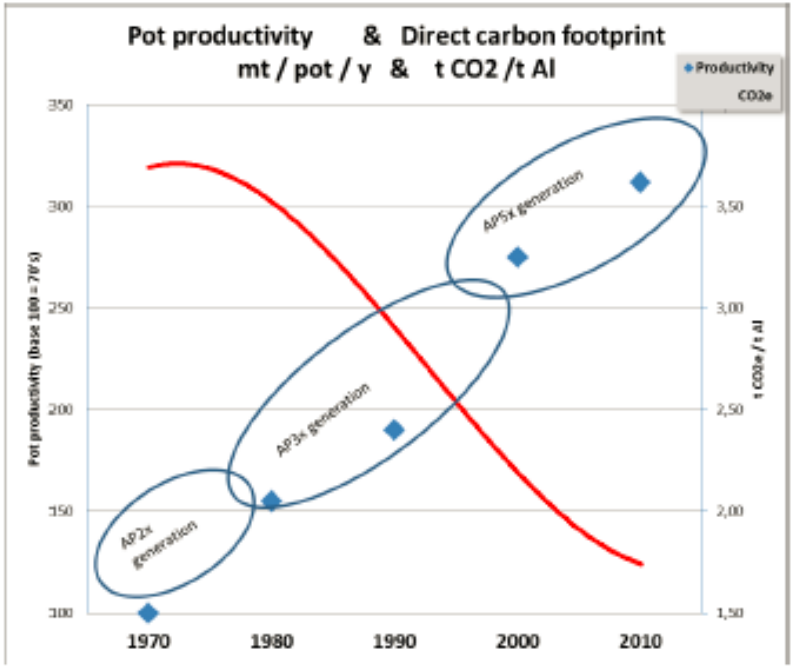
HORIZON 2020
LE PROGRAMME DE RECHERCHE ET D'INNOVATION DE L'UNION EUROPÉENNE

Use of extrusion for recycling TP composites

RioTinto Alcan – sustainable development and competitiveness

RioTintoAlcan

Improving productivity while reducing Greenhouse Gases (GHGs)



- **Best-in-class AP technology™(i.e. APXe)**
- **Technological breakthrough** (inert anodes)
- **Operational excellence** (HSE, quality, process, eg. anode effects)
- **Clean and secure energy**

Rio Tinto Alcan has been a leader in the development and implementation of GHG reduction technologies

Cercle de l'Industrie - Approaches to deliver sustainable competitiveness

New approaches to deliver sustainable competitiveness

21th century

- optimize → materials composition + part design + manufacturing efficiency
- triple win → more functionalities, lower costs, better environmental footprint

Conclusion – Special focus of the Theme 3

Numeric aspect:

- Computer and material simulations to speed up discovery process
- Use simulation for validation of new technologies and not only discovery
- Internet of Things to improve productivity and sustainability

Organizational behavior:

- Multi-skilled teams and interdisciplinary research approach
- Benchmarking technologies and their cross industry transfer

I would like to give warm thank all speakers and Anna Stepien