What biomaterials for automotive: today and tomorrow?

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Thank you for your attention
Outline

▶ Introduction
  ▶ Automotive industry challenges
  ▶ Peugeot Citroën innovation : STELLAB
  ▶ Reduce environmental impact : Ecodesign

▶ Materials inside a car
  ▶ Materials distribution
  ▶ Plastics inside a car
  ▶ Peugeot Citroën objectives for green materials using

▶ Green Materials application todays : existing or potential
  ▶ Application area
  ▶ Natural fibers
  ▶ Bio-polymers

▶ Bio-materials for tomorrow

▶ Conclusions
Two brands with strong and differentiated identities
Challenges: Innovation & Sustainable Development

- Provide additional benefits for customers & society
  - Safe cars
  - Within everyone’s reach
  - Adapted to use

- Reduce vehicles emissions
  - CO₂
  - Pollutants

- Reduce environmental impact
  - Recyclability
  - Materials
Peugeot-Citroën Innovation : STELLAB

StelLab is a scientific management structure responsible for:

► Creating and managing our OpenLabs network

► Setting up a network of doctoral candidates, research and scientific engineers and Group experts

► Hosting students and researchers (doctoral candidates and above) chosen to take part in scientific programs initiated by PSA Peugeot Citroën as part of its scientific partnership program

► Organising multidisciplinary seminars in technology, design, marketing and other fields that will be open to leading academics.

OpenLabs are joint research units which will pool the Group’s research teams and testing resources with those of partner laboratories.
Reduce environmental impact at each step in the vehicle life cycle: ECODESIGN

- **Engines**
  - Cut fuel consumption and CO₂ emissions

- **Materials**
  - Optimise the use of natural resources

- **Lower vehicle mass**

- **Recyclability**
  - Reduce the impact of end-of-life vehicles

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**Green Materials**

Low particulate matter and CO₂ emissions

Low fuel consumption; Hybrid engine
Materials inside car

The average weight

1 250 Kg

Nowadays, for PSA vehicles

Metals : 883 Kg
70,2%

Polymers : 278 Kg
22,3%

Others : 94 Kg
7,5%

Nowadays, for PSA vehicles

: 150 – 200 kg

of plastics

PP
44%

PUR
13%

PA
9%

Divers
9%

Polyester
8%

ABS
6%

SAN
5%

PE
5%

PMMA
2%

PC
2%

PVC
2%

PBT
2%
Peugeot Citroën objectives for green materials using:

- **70% of metals**
  - 100% recyclable

- **5% of fluids, 5% others**

- **20% of polymers**
  - 150 to 250 kg of plastics

Objectives: 22% of green materials in 2012

Without specification modifications

Example of 208: 41.5 kg (24.4%) of green materials

- 19% of natural materials (fibers and leather)
- 2% of bio polymers
- 79% of recycled materials
Natural fibers use

- *Thermoformed parts*

- Floor carpet
- Rear floor
- Rear parcel shelf
- Liner trunk
- sound deadening of dashboard
- Rear parcel shelf
Natural fibers use

- **Plastics for injection**
  - cap of de-aeration: PA substitution by PP 30% hemp (in all vehicles)
  - platinise rearview mirror of the 207: PP 30% GF substitution by PP 30% hemp

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Door panels and medallions:
substitution PP 20% mineral fillers by
un PP 20% hemp

**Benefits**: Mass saving and LCA improvement
Bio-polymers use

Bio polymers nonbiodegradable

- Polyamide
  - Amino undécanoic acid
  - Décaméthylène diamine
  - Sebacic Acid

- Castor Oil
  - Hexaméthylène diamine
  - Dodécandioic Acid
  - Diaminobutane

PA11
PA1010
PA610
PA1012
PA410
PPA
# Bio-polymers use

- **Polyamides**: Comparison of the principal properties

<table>
<thead>
<tr>
<th>Materials</th>
<th>PA66</th>
<th>PA12</th>
<th>PA610</th>
<th>PA1010</th>
<th>PPA</th>
<th>PA410</th>
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</thead>
<tbody>
<tr>
<td><strong>Mechanical</strong></td>
<td>+++</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td><strong>resistance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Glycol</strong></td>
<td>- to +</td>
<td>+++</td>
<td>++</td>
<td>+++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>resistance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fuel</strong></td>
<td>--</td>
<td>++</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>NC</td>
</tr>
<tr>
<td><strong>resistance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Thermal</strong></td>
<td>++</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td><strong>resistance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>% Bio</strong></td>
<td>0</td>
<td>0</td>
<td>62</td>
<td>100</td>
<td>48</td>
<td>70</td>
</tr>
<tr>
<td><strong>Density</strong></td>
<td>1,15</td>
<td>1,02</td>
<td>1,08</td>
<td>1,04</td>
<td>NC</td>
<td>NC</td>
</tr>
</tbody>
</table>
Bio-polymers use

- Bio-based polyamide applications

FUEL SYSTEM
Material: PA11

COOLANT CIRCUIT
Material: PA11

PA 6,10 DuPont

- Substitution of the Aluminium by RILSAN HT for the tubes of EGR valves
Bio-polymers use

Polyamide: possible applications

- **CONNECTORS**
  - Standard Material: PA66
  - Possible BM: PPA, PA610

- **LEFT BOX WATER**
  - Standard Material: PA66
  - Possible BM: PA610

- **BLENDING OF TURBO LEFT**
  - Standard Material: PPA petrochemical
  - Possible BM: PPA, PA610
Bio-polymers use

- Bio-based PU: foam for sit

Substitution of polyol from oil (10 to 25%) by bio-based polyol (reactivity)

Polyurethan Foam

Iso-cyanate + Polyol + Catalyst = Amine

Green Polyol hydroxylated polymers

Soybean, Sunflower, Rapeseed...

Groups -OH
Bio-polymer use

- PTT: bio-bases from bio-alcohol

Made with Bio-PDO™,
DuPont™ Sorona® polymer
is 37% renewably sourced

1,3-propanediol + DMT

Bio-PDO™

Catalyst

Poly Trimethylene Terephthalate (PTT, 3GT)

Sorona® is a high performance polymer
with unique molecular structure leading to:
- Toughness
- Stretch & recovery
- Resilience & elasticity
- Softness
- Thermo-formability

2GT, Poly Ethylene Terephthalate
Sorona® 3GT, PTT

4GT, Poly Butylene Terephthalate
Bio-polymers use

- Other bio-polymer available
  - PLA (Poly Lactid Acid): for PSA, limitation of use due to the difference with our standard specifications
Bio-materials for tomorrow

- Develop with a specific target: without specification modifications

- Conserve or improve mechanical properties

- Don’t increase the parts weight (better to decrease)

- Be careful to the cost !!!!
Bio-materials for tomorrow: MATORIA

- Budget: 7,8 M€
- Starting 2008 end 2012

To gather all the sector
Bio-materials for tomorrow: MATORIA

- Objectives: Develop new bio-materials which are compatible with Automotive specifications

PA bio-based (semi-aromatic)

Starch grafted Polyolefine

Composites based flax fiber

Dashboard part (1007)

Valve timing cover
Bio-materials for tomorrow: MATORIA

- Other applications possible

Amidon grafted Polyoléfine

[Images of various products and logos for Roquette and Gaialene]
Bio-materials for tomorrow: Finather

NAatural Fibre THERmoset composites for automotive, railway and furniture markets

- **Aim**
  - Develop composite elements made from hemp / flax (30%) and resin oilseed (70%) enhancing natural materials and know-how of FRD and ARD
  - Develop bio-based materials with 75% renewable carbon

- **Budget** = 3.6 million euros over 4 years

- **Partners**
  - Automobile Industry: PSA Peugeot-Citroën, Plastic Omnium (MCR), Renfortech
  - Rail Industry: Alstom Transport, Compin CCFE
  - Luxurious Furniture: Corima SA
  - Natural Materials: FRD (fibers) + ARD (resins)
  - Research Centers:
    - Institut Charles Gerhardt de Montpellier,
    - Institut Français du Textile et de l’Habillement
    - Université Bretagne Sud
    - Université de Technologie de Troyes
Bio-materials for tomorrow: BFF

BIOMASS FOR THE FUTURE

- A « Stimulus Initiative » for the development of local ligno-cellulosic biomass-based (Miscanthus) value chains in France
**Bio-materials for tomorrow : BFF**

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Industrial uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agronomy, logistics, life cycle analysis</td>
<td>• Combustion</td>
</tr>
<tr>
<td>Genomics-assisted accelerated Plant breeding for improving yield, environmental footprint, biomass quality</td>
<td>• Anaerobic digestion</td>
</tr>
<tr>
<td></td>
<td>• Building materials</td>
</tr>
<tr>
<td></td>
<td>• Fiber-reinforced composites</td>
</tr>
</tbody>
</table>

- **Period**: 2012 - 2020
- **Budget**: 28 M€ with 10 M€ government support
- **22 partners**

**Miscanthus**
Bio-materials for tomorrow: PUREs (PU isocyanate free)

Polyuréthanes respectueux de l’environnement et de la santé
Or Polyurethans environmental and health respectful

SOPREMA
INSTITUT CARNOT MICA
PSA PEUGEOT CITROËN

Li PHT

LE PÔLE ALSACE ÉNERGIVIE
Strasbourg.eu
Région Alsace e-CPM
UNIVERSITÉ DE STRASBOURG
CNRS
Bio-materials for tomorrow: PURES (PU isocyanate free)

Etape 1: Acylation

Etape 2: Esterification

Etape 3: Aminolyse

Before Elongation

Elongation

After Elongation
Bio-polymer for tomorrow: bioraffineries

Nowadays, for PSA vehicles:
- Metals: 883 Kg (70.2%)
- Polymers: 278 Kg (22.3%)
- Others: 94 Kg (7.5%)

150 – 200 kg of plastics
And now....

- Availability of volumes of materials
  - Need for developing the sectors in all the countries

- Bio-based polymers: opportunities and risks
  - Not yet mature processes / petrochemicals >> R & D
  - Environmental questions must be raised:
    - Competition with the production of food
    - Land use cultivable
    - Need for comprehensive LCA for each organic-processes

- Development of the use of the composites....
Thank you for your attention