INVESTOR DAYS

# An introduction to R&D

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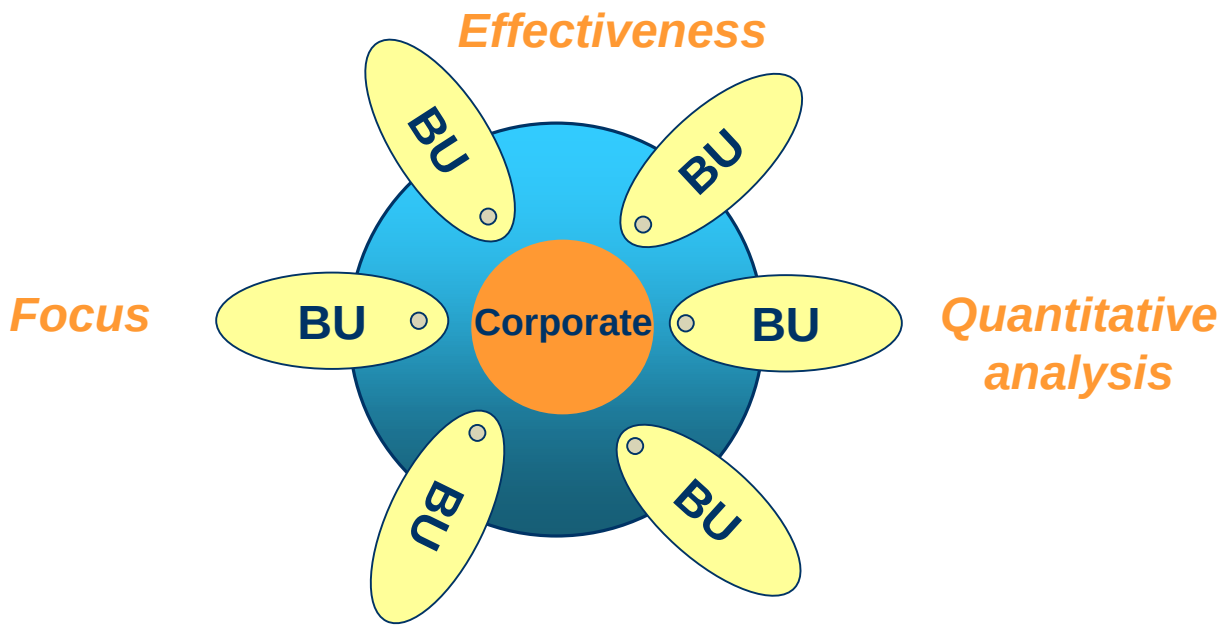
ARKEMA

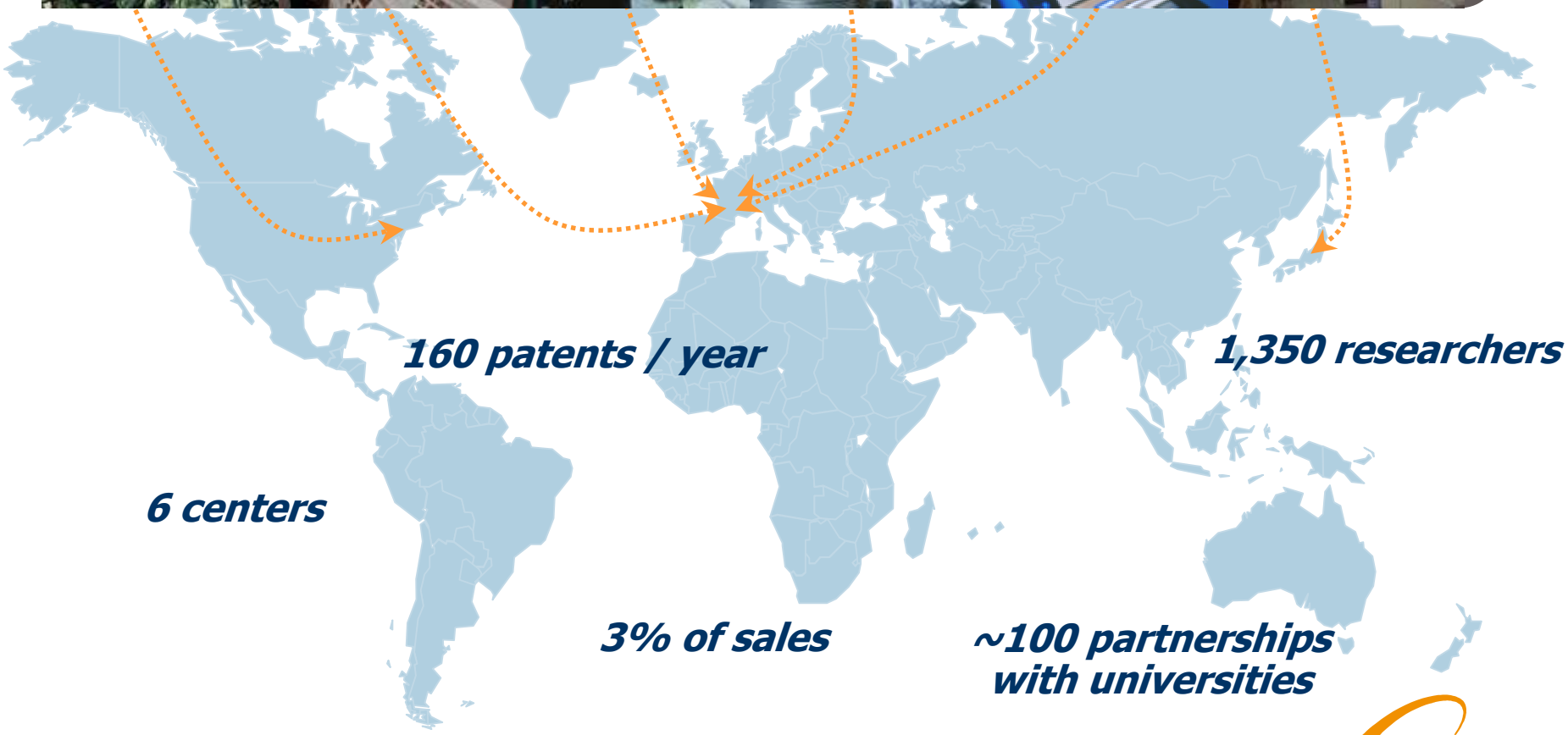
# R&D as part of the overall strategy

- Develop downstream businesses of our best product lines
- Build tomorrow’s growth platforms
- Continuous improvement of our production processes

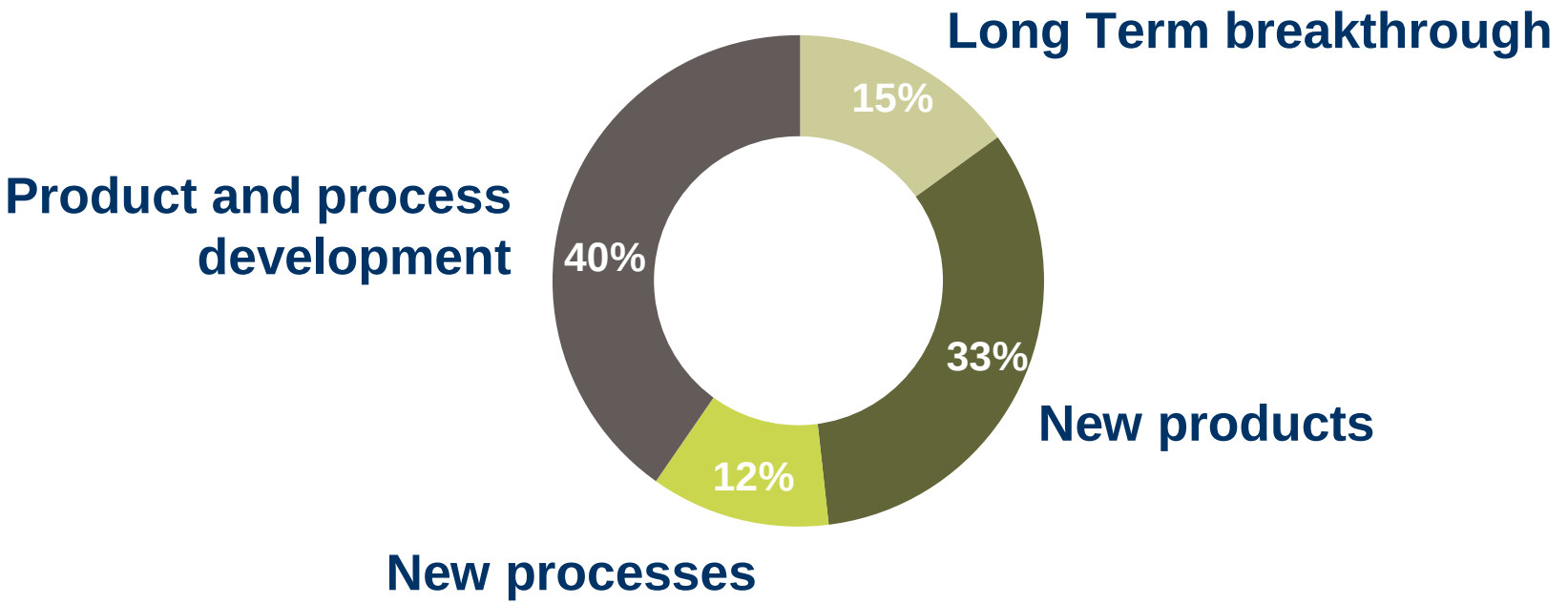


# A worldwide presence

KING OF PRUSSIA | LACQ | SEROUIGNY | CARLING | PIERRE-BÉNITE | KYOTO



# Well balanced portfolio of projects

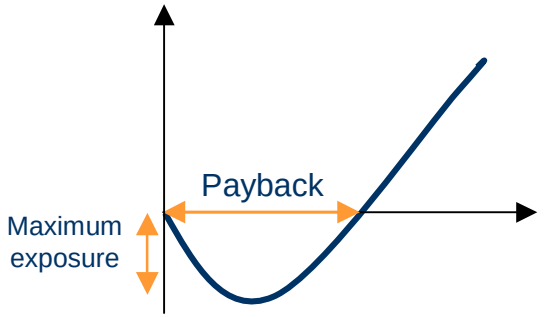



***€168m - 3% of sales***

# A detailed and analytical process

- **Continuous analysis of project potential**
- **A stage gate process**
- **Reallocate resources**
  (1/3 of projects stopped within 2 years)
- **Yearly review by Executive Committee**
- **Financial and risk analysis**

**Financial and risk analysis**

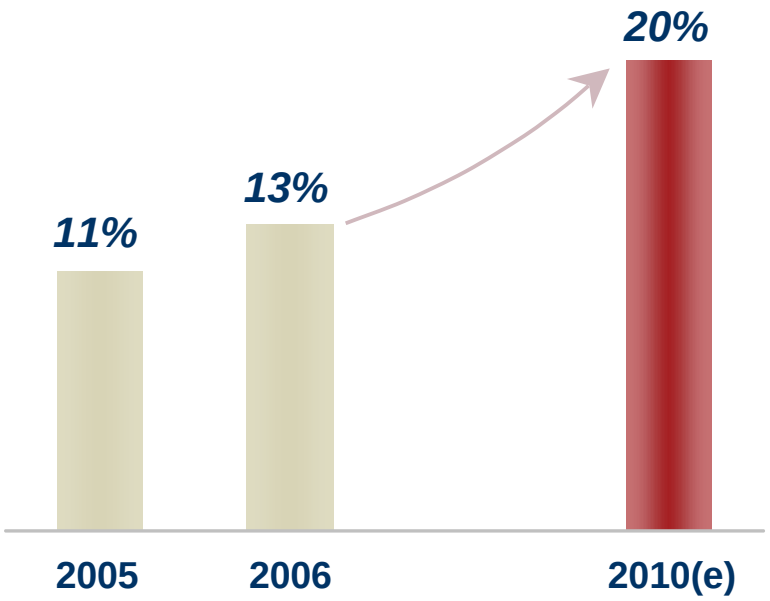



**Gates approval process**

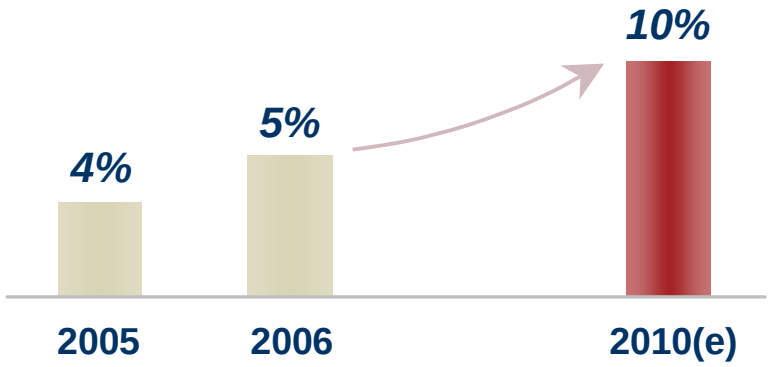
**Scoping** | **Gate 1** | **Feasibility** | **Gate 2** | **Pre project** | **Gate 3** | **Basic engineering** | **Gate 4** | **Execution**

# Clear and ambitious targets

**20% of 2010 Performance Products sales generated by products less than 5 years old**




**10% of Arkema sales from renewable resources**

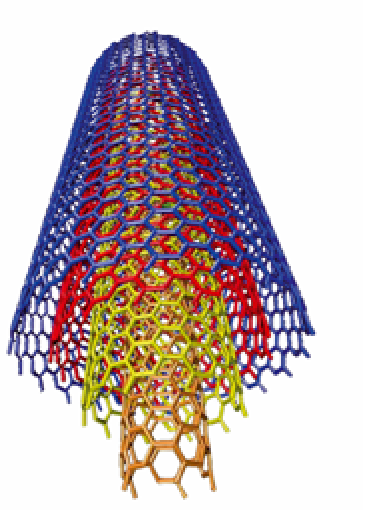


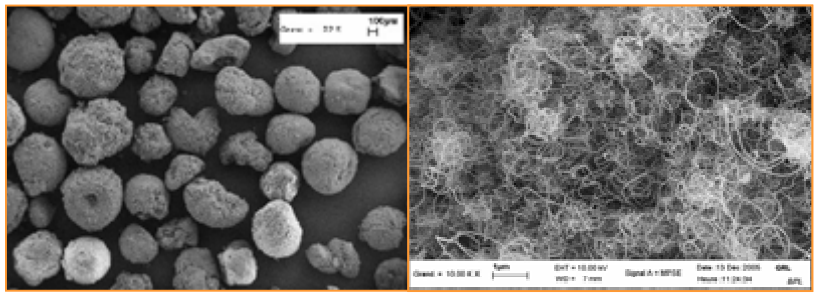
# Main R&D breakthroughs

| | Vinyl Products | Industrial Chemicals | Performance Products |
|---|---|---|---|
| **Nanostructured materials** | | *Enhanced PMMA* | *Carbon Nanotubes* |
| **Products from renewable resources** | | *Glycerol to Acrylic Acid* | *Technical polymers and alloys* |
| **Materials for new energies / environment applications** | | | *Fuel cell*<br>*Photovoltaic panels*<br>*Bitumen* |
| **Process intensifications** | *Electrolysis* | *F 125*<br>*Acrylics* | |

# Carbon nanotubes

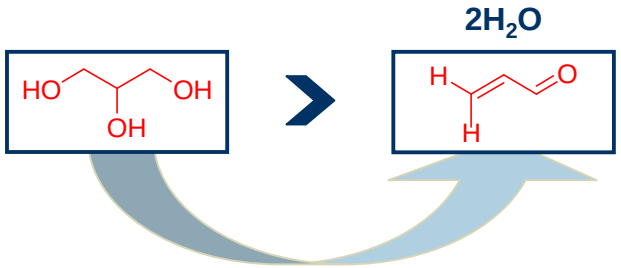
- **Production facility: pilot lab designed to produce around 10 tonnes per year of multi-wall carbon nanotubes** (MWNT)
- **CCVD process**
- **Production of black powder**
  - Dust-free powder, apparent density ~ 100-150 kg/m$^3$, average agglomerate size: 400 µm
  - Standard grade: Graphistrength™ C100
- **MWNT features**
  - Diameter: 10 –15 nm, length: 1 – 10 µm, Mean number of walls: 5 - 15

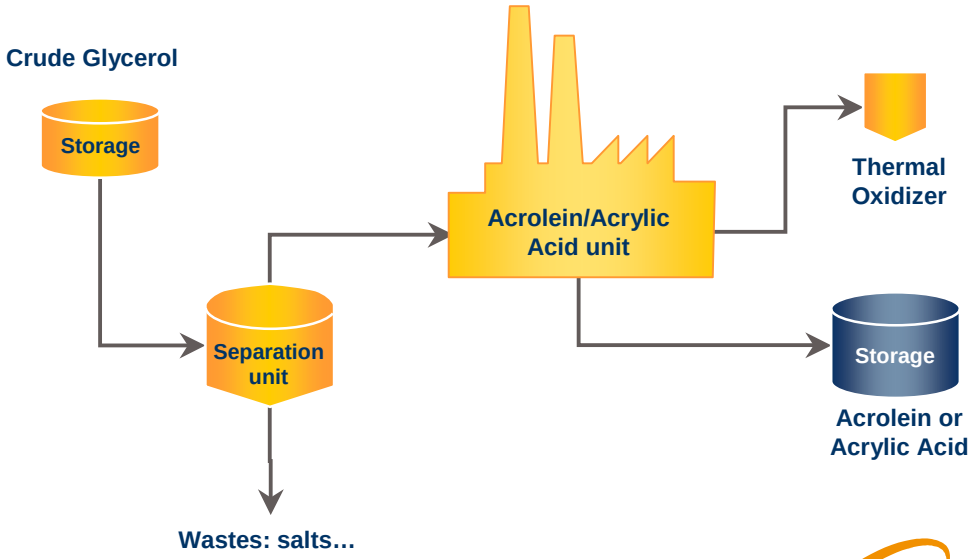




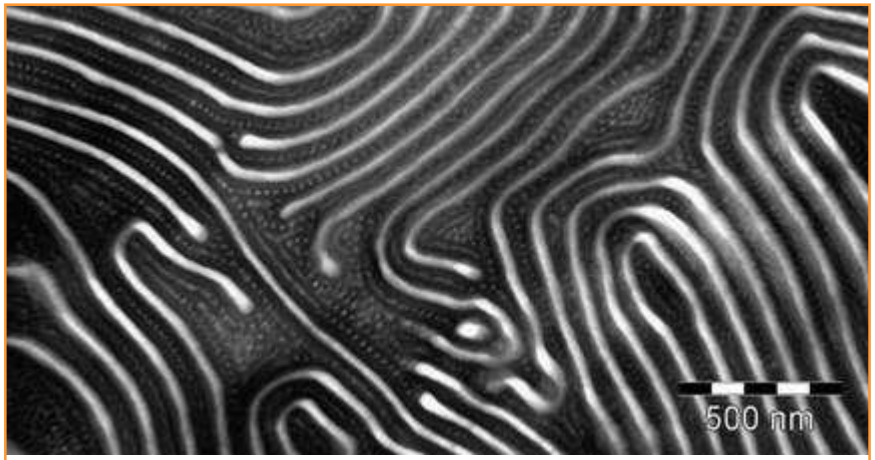
# Acrolein/Acrylic acid from Glycerol

- Acrolein and Acrylic Acid are currently produced by selective oxidation of propylene
- Double dehydration of Glycerol leads to acrolein, and further oxidation to Acrylic acid



# Nanostructured materials

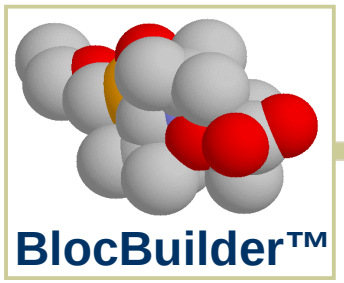


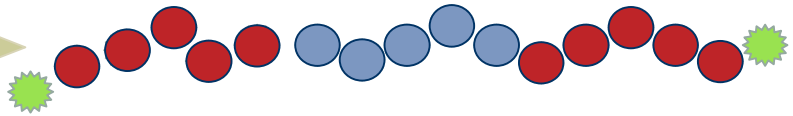

Nanostructured copolymers

## Modifying properties

- Appearance
- Durability
- Protection

### Control Radical Polymerization

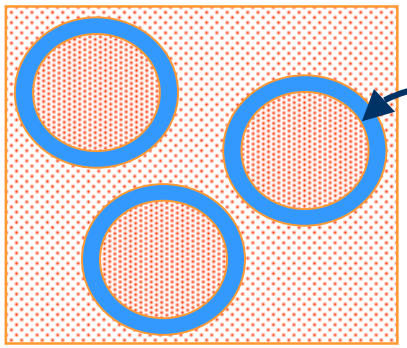


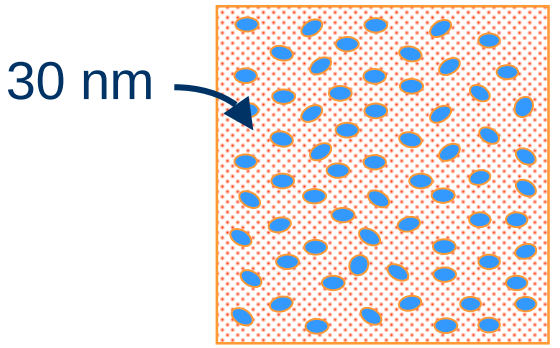



Monomers

: controller

# Impact PMMA with MAM Block Copolymer




- RT-PMMA Multi-phase Structure
  - Toughness: Good
    Optics: Good
  - Viscosity: High
    Modulus: Low
  - Temp. Haze: Poor

- CRP Block Copolymer
  - Toughness: Good
    Optics: Excellent
  - Viscosity: Moderate
    Modulus: Moderate
  - Temp. Haze: Good

# New higher added value applications for PMMA

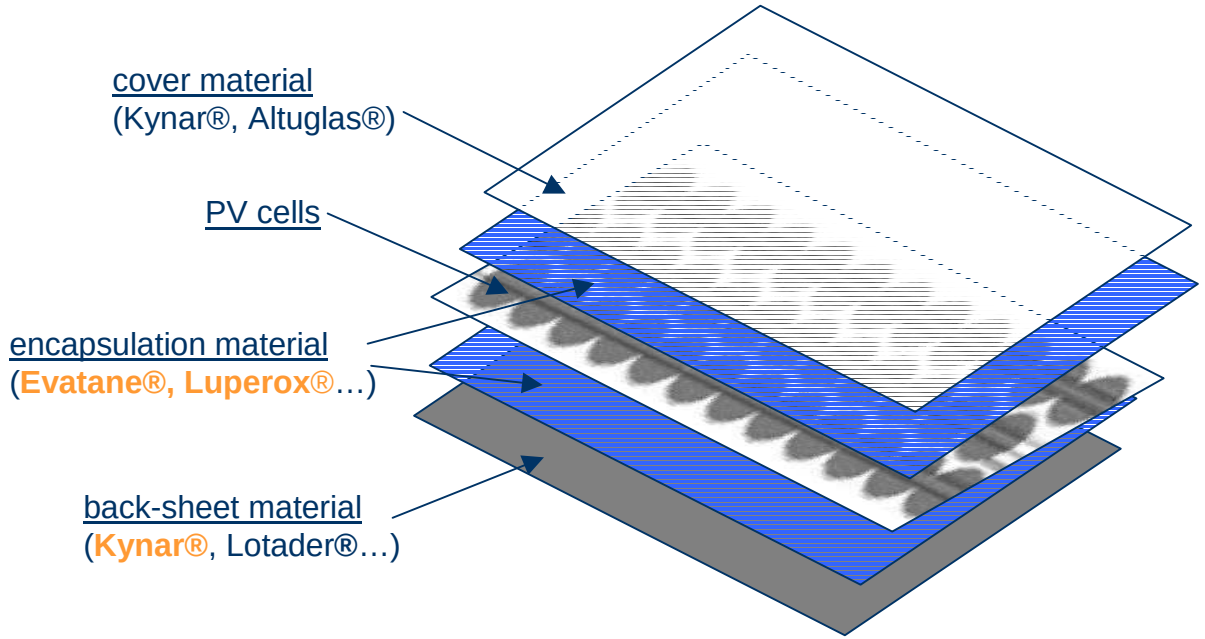
## Auto Headlamp Lenses

## High Performance Acrylic Film

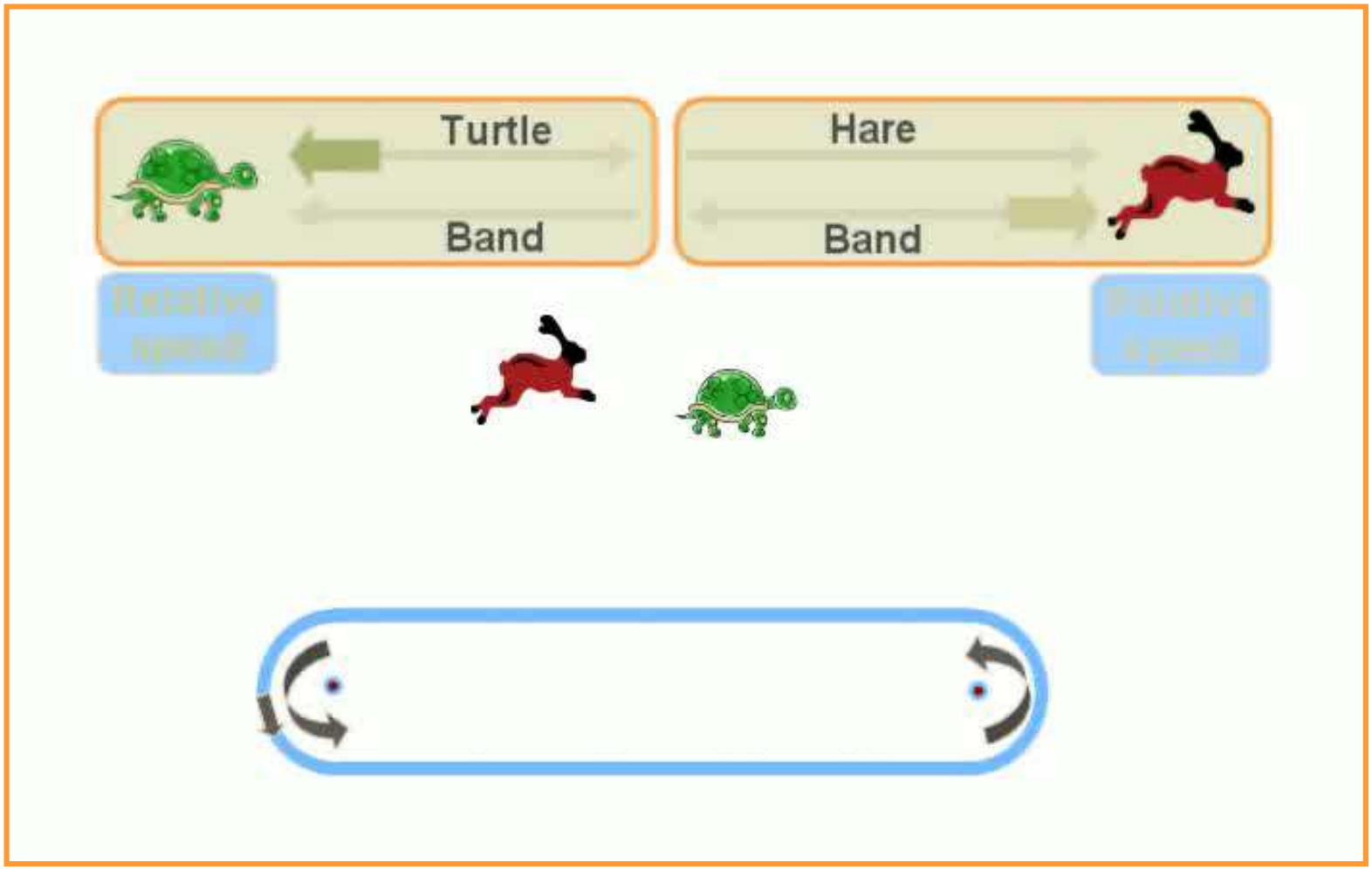
## Acrylic Capstock for PVC

# A global approach to the Photovoltaic market

- **Federate all Arkema PV development**
- **Define partnerships for US and European markets**
- **Initiate new PV R&D project platform**



# Simulated mobile bed reactor



# Bitumen additive – 2007 Pierre POTIER Award

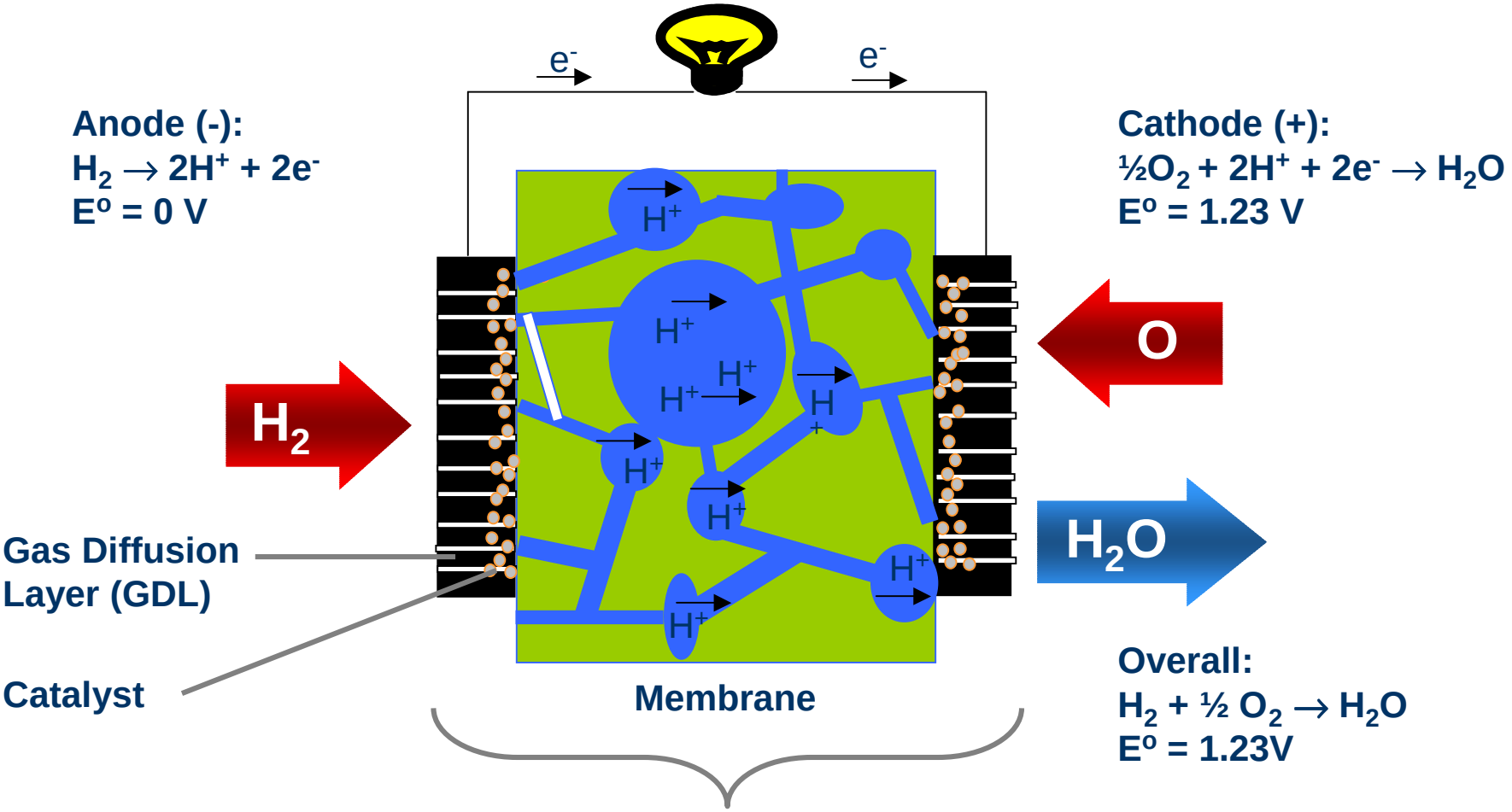
Without additive

Bitumen at 160°C

With additive

Bitumen at 120°C

# New membranes for fuel cells



# Conclusion

- Innovation is one of the three strategic priorities of Arkema
- Very focused approach, less projects, more efficiency
- Develop our strengths: nanostructured materials, catalysts…
- Quantified and ambitious targets
- Strong link between R&D and marketing
- Define tomorrow's needs and position Arkema accordingly

***R&D: a catalyst for growing specialties***