The Solus challenge
How to support a new wafer plant
7th Innovationsforum Dresden January 2010
Ludo Vermeiren
Introducing Umicore
From transformation to growth

Umicar “Infinity”, the solar powered car, sponsored by Umicore, which ended second in the 2007 World Solar Challenge, raced in Australia.
Umicore in the past - a bit of history …

mining → ores & raw materials → refining → metals → transformation → metal compounds
* Smaller acquisitions not mentioned in this overview
A history of transformation

1906: Union Minière du Haut Katanga: Copper and Cobalt mining (nationalised in 1967)

1989: Union Minière merger with Metallurgie Hoboken and Vieille Montagne
Base metals refining and some specialty materials

2001: Name changed to Umicore
Focus on growing/developing specialty materials businesses

2003: Acquisition of former Degussa precious metals products and catalyst business (PMG)

2005: Spin off of Cumerio (copper refining)

2006: Carve-out of Zinc Smelting/Alloys (Nyrstar JV with Zinifex created)

2007: Strategic repositioning completed (IPO of Nyrstar)
Today, our company is…

- Umicore is one of the world’s biggest suppliers of automotive catalysts for passenger cars

- Umicore is a world leader in the production of key materials for rechargeable batteries used in laptops and mobile phones

- Umicore’s germanium substrates for high-efficiency solar cells are used in the bulk of the satellites launched today

- Umicore is the world’s largest recycler of precious metals from old mobile phones, laptops, electronic scrap or spent catalyst material
“Less is more”

Metal related materials can be efficiently and infinitely recycled, which makes them the basis for sustainable products and services.
## Global market leadership in four divisions

<table>
<thead>
<tr>
<th>Division</th>
<th>World Rank</th>
<th>Product Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Materials</td>
<td></td>
<td>Cobalt &amp; Germanium materials</td>
</tr>
<tr>
<td></td>
<td>#1 World</td>
<td>Rechargeable battery materials</td>
</tr>
<tr>
<td>Precious Metals Products &amp; Catalysts</td>
<td>Top 2 World</td>
<td>Automotive catalysts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brazing alloys &amp; contact materials</td>
</tr>
<tr>
<td>Precious Metals Services</td>
<td>Top 3 World</td>
<td>Precious metals recycling</td>
</tr>
<tr>
<td></td>
<td>#1 World</td>
<td>PGM refiner</td>
</tr>
<tr>
<td></td>
<td>#4 World</td>
<td></td>
</tr>
<tr>
<td>Zinc Specialties</td>
<td></td>
<td>Zinc specialty products</td>
</tr>
</tbody>
</table>
Umicore today: global footprint

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>€865m</td>
<td>€2,123.6m</td>
</tr>
<tr>
<td>Number of sites</td>
<td>32</td>
<td>85</td>
</tr>
<tr>
<td>Workforce</td>
<td>8,065</td>
<td>15,500</td>
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</table>
Transformation of Umicore: growth of earnings and Return on Capital Employed
Transformation of Umicore: a changing investment profile

Capital-intensive metals refining industrial

R&D-intensive materials technology company
A decentralised, customer-focused organisation

Group structure - As of August 1, 2009
Advanced Materials

Leading global position in cathode materials for lithium–ion batteries; cobalt powders for hard metal applications, germanium substrates for space solar cells.

Produces high-purity metals, alloys, compounds and engineered products for a wide range of other specialist applications.

Advanced Materials has industrial operations around the world.

<table>
<thead>
<tr>
<th></th>
<th>1H08</th>
<th>2H08</th>
<th>1H09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>205.2</td>
<td>198.8</td>
<td>153.9</td>
</tr>
<tr>
<td>EBIT (recurring)</td>
<td>378</td>
<td>33.3</td>
<td>0.5</td>
</tr>
<tr>
<td>EBITDA</td>
<td>52.5</td>
<td>33.8</td>
<td>0.5</td>
</tr>
<tr>
<td>ROCE %</td>
<td>16.3</td>
<td>14.0</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Synthetic diamond and super-abrasives activities are conducted in a joint venture with Element Six.
Precious Metals
Products & Catalysts

Umicore is one of the leading producers of automotive catalysts for passenger cars.

Other products and services are based on precious metals (most often PGMs) and used in a wide variety of industries incl. jewellery, electroplating, glassmaking, electronics and in various chemical processes.

The business has a global reach with production sites on four continents.

<table>
<thead>
<tr>
<th></th>
<th>1H08</th>
<th>2H08</th>
<th>1H09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>1,836.9</td>
<td>1,430.2</td>
<td>1,053.9</td>
</tr>
<tr>
<td>EBIT (recurring)</td>
<td>82.9</td>
<td>20.2</td>
<td>(9.7)</td>
</tr>
<tr>
<td>EBITDA</td>
<td>99.7</td>
<td>34.8</td>
<td>9.8</td>
</tr>
<tr>
<td>ROCE %</td>
<td>18.6</td>
<td>4.5</td>
<td>(2.3)</td>
</tr>
</tbody>
</table>
Umicore is the world leader in the recycling of precious metals. It provides recycling and refining services at its plant in Hoboken, Hanau and in Brazil. Recovers 17 metals including precious metals such as: gold, silver, platinum, rhodium and palladium.

Metals Management offers for, among others, the hedging, leasing, purchasing and sale of precious metals.

The main feed materials are by-products of the non-ferrous metal and photographic industries, spent automotive and industrial catalysts and electronic scrap.

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<th>1H09</th>
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</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>207.4</td>
<td>212.7</td>
<td>182.7</td>
</tr>
<tr>
<td>EBIT (recurring)</td>
<td>86.0</td>
<td>97.8</td>
<td>60.9</td>
</tr>
<tr>
<td>EBITDA</td>
<td>106.0</td>
<td>112.2</td>
<td>77.0</td>
</tr>
<tr>
<td>ROCE %</td>
<td>76.5</td>
<td>83.1</td>
<td>62.6</td>
</tr>
</tbody>
</table>
Umicore produces zinc materials and chemicals used for anti-corrosion properties in paints and construction materials. Other applications include powders for primary batteries and zinc chemicals for catalysis.

Umicore is also a leading zinc recycler and recycling is central to its closed loop business model.

Production is focused in Belgium, France, the Netherlands, Norway and the Asia-Pacific region.

<table>
<thead>
<tr>
<th></th>
<th>1H08</th>
<th>2H08</th>
<th>1H09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>389.9</td>
<td>300.5</td>
<td>132.6</td>
</tr>
<tr>
<td>EBIT (recurring)</td>
<td>29.9</td>
<td>16.7</td>
<td>19.7</td>
</tr>
<tr>
<td>EBITDA</td>
<td>39.0</td>
<td>27.2</td>
<td>30.7</td>
</tr>
<tr>
<td>ROCE %</td>
<td>19.2</td>
<td>12.0</td>
<td>14.0</td>
</tr>
</tbody>
</table>
Research & development expenditure: driving organic growth

- Research & development expenditure
  - up 32% yearly over last 6 years
  - up 6% yearly since PMG acquisition
- Stable level at some 6-7% of revenues
- Focus on clean technologies

(in million €)

<table>
<thead>
<tr>
<th>Year</th>
<th>R&amp;D</th>
<th>R&amp;D / revenues</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>30.5</td>
<td>-2.46%</td>
</tr>
<tr>
<td>2003</td>
<td>47.8</td>
<td>3.25%</td>
</tr>
<tr>
<td>2004</td>
<td>103.8</td>
<td>5.35%</td>
</tr>
<tr>
<td>2005</td>
<td>111.7</td>
<td>5.71%</td>
</tr>
<tr>
<td>2006</td>
<td>114.8</td>
<td>5.83%</td>
</tr>
<tr>
<td>2007</td>
<td>124.5</td>
<td>5.80%</td>
</tr>
<tr>
<td>2008</td>
<td>166.0</td>
<td>7.00%</td>
</tr>
</tbody>
</table>
80% of R&D expenditure in clean tech domain

innovative technologies specifically designed to optimise the use of natural resources and to reduce environmental impact
Where can Umicore play a role in Cleantech?

Creating value by reducing the use of rare and valuable materials

- **Energy Solutions**: Materials for energy storage and sustainable energy production
- **Recycling Solutions**: Addressing resource scarcity and emissions by closing the materials loop
- **Environmental Solutions**: Technologies to mitigate environmental impacts
Energy solutions: solar cells
Key materials for high-efficiency solar cells: germanium

- Germanium substrates constitute the building blocks of very efficient solar cells which are primarily used in satellite solar panels.
- Ge-based solar cells are up to twice as efficient in converting solar power into electricity than silicon-based cells.

Umicore provides the germanium substrate, onto which other layers are “grown”. Each layer captures part of the solar spectrum.
Energy solutions: solar cells
Different materials for different applications

- Growing market of high-efficiency terrestrial solar cells:
  Using a set of mirrors or lenses, the sunlight is concentrated (factor of X 1000) on a small germanium substrate

- Thin film solar cells:
  Umicore supplies key metals (tellurium, selenium, indium) and materials (conductive layers) for thin film solar cells

- Solar grade silicon:
  Hycore JV research into energy-efficient product process for solar grade silicon
Energy solutions: fuel cells
Umicore supplies electro-catalyst material

- Fuel cells generate electricity using hydrogen as the energy carrier
- Hydrogen reacts with oxygen, creating electricity
- The catalyst material sets this chemical reaction in motion
- SolviCore JV (Umicore/Solvay) produces membrane electrode assemblies (“heart” of fuel cell)
Energy solutions: fuel cells
Power source of the future?
Energy solutions: Rechargeable batteries

Storing energy

- Umicore has leading position in cobalt-based active material (cathodes) for lithium-ion rechargeable batteries
- Portable electronics applications (mobile phones & laptops) drive growth
- Success factors: lighter; smaller; high capacity; long life
Energy solutions: Rechargeable batteries
Expanding to other applications

- Hybrid Electric Vehicles
- Power tools
- New materials offer the potential for Li-ion to become the key enabler for electrified drive trains
Environmental solutions: automotive catalysts
“Clean air is our business”

- Umicore is one of the world’s largest producers of automotive catalysts for light duty vehicles (passenger cars)
- Active in the development of heavy duty vehicles (trucks & buses …)
- High premium on technological development due to increasingly stringent emission regulation

<table>
<thead>
<tr>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
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<tbody>
<tr>
<td>Heavy Duty</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>EU 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Europe</td>
</tr>
<tr>
<td>US 2004</td>
<td></td>
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<td></td>
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<td></td>
<td>US</td>
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<tr>
<td>EU 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU 4 (Beijing)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>China</td>
</tr>
<tr>
<td>EU 4 Diesel (Draft)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Korea</td>
</tr>
</tbody>
</table>

driven by
- worldwide automotive production
- environmental legislation
- consumer awareness
Environmental solutions: automotive catalysts
“Clean air is our business”

- Precious metals (platinum, palladium, rhodium) react with harmful emissions from combustion engines, rendering these gases largely harmless
Recycling solutions
Recovering scarce and valuable metals

- The majority of Umicore’s raw materials supply for its refining operations comes from secondary materials (end-of-life materials and industrial by-products)
- Umicore operates the world’s largest precious metals recycling operation in Hoboken (Belgium)
- Hoboken processes some 350,000 tonnes every year from more than 200 different materials

```
Spent industrial catalysts  Electronic scrap  Spent automotive catalysts  Precious metal bearing raw materials  Non-ferrous byproducts
```

- “Above ground mining” means less energy and less waste → more value
Recycling solutions
Recovering scarce metals from e-scrap

• Obsolete mobile phones contain valuable precious metals such as gold (Au), silver (Ag) or palladium (Pd) which Umicore is able to capture

• Currently, only 1-2% of all mobile phones are recycled worldwide, offering huge potential

• We also recycle the batteries
Introducing EOM
From refining to advanced transformation

Umicar “Infinity”, the solar powered car, sponsored by Umicore, which ended second in the 2007 World Solar Challenge, raced in Australia.
Electro-Optic Materials a business unit of Umicore

Group structure · As of August 1, 2009
Electro-Optic Materials
2 business lines in 4 locations

BL Substrates

2 Business Lines

BL Optics
Thermal Imaging

Fiber Optics
Electro-Optic Materials
Mission statement

- We provide customised germanium-based material solutions for infrared optics and opto-electronics applications.
- We focus on high added value products and high volume markets.
- We make the difference through:
  - our skilled and dedicated people
  - our continuous innovation built on a solid technological base
  - our recycling competencies and secured supply
  - our effective customer support
Electro-Optic Materials
Revenues in 4 locations worldwide

Geographical Distribution of Sales

- **EOM Olen (Belgium)**: Ge recycling & transformation into IR Optics & Substrates
- **UOM Quapaw (OK, USA)**: GeCl₄ & Ge for IR Optics, GASIR assemblies
- **UIRG Acigné (France)**: competence centre Chalcogenide glasses; GASIR
- **UCS Dundee (UK)**: competence centre for coatings

Global workforce: 365
Electro-Optic Materials
From refining to advanced transformation in 10 years

Ge Refining & Primary Transformation

- GeO2
- GeCl4
- Ge blanks

Added value between 0.25 and 2 times material value

Advanced Transformation

- Ge Substrates
- GASIR® Assemblies

Added value is now 10 to 20 times material value
Electro-Optic Materials

Flow sheet: recycling is key to our business
BL Optics
GeCl₄ and applications

- Germaniumtetrachloride (GeCl₄) - Ultra Pure is used as an additive in the manufacturing of optical fibers

- GeCl₄ is packed in stainless steel containers up to 400 kg, with a special designed 3 valve system, preventing every contamination by air. Flexible and effective logistics are secured.

- Recycling of germanium is a key issue in the optical fibre business, offering direct cost saving and security of supply. Umicore’s recycling capabilities allow efficient recycling of a various range of Ge containing residues.
BL Optics
IR applications

Driver Vision Enhancement (DVE)

Medical

Defense

Predictive Maintenance

Surveillance & Security

Border Control

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BL Optics Products

- **Ge blanks** (lenses & windows)
  - thermal imaging (8 – 12µ) incl. finished components
    (polishing & coating)

- Substituting Ge blanks by Ge bearing **chalcogenide glass GASIR®** = finished Optics with high added value
  - less dependant on Germanium metal price & USD
  - Mass production made easier (moulding techniques)

A dedicated high volume GASIR® Optics plant was built in 2005 in Quapaw (OK US)
BL Optics
Examples of IR cameras with Ge and/or GASIR® lenses/assemblies
BL Optics

Umicore lenses in BMW night vision camera
BL Substrates

Applications

Space Photo-Voltaïcs

Terrestrial Photo-Voltaïcs

LED's
BL Substrates

Products

- **Ge Substrates**:  
  - Available range from diameter 1 inch until 12 inch  
  - Very high quality requirements depending on application  
  - Specification in accordance to customer requirements (lenses & windows)
BL Substrates

Civil Space and U.S Security Programs

Global Positioning System

GOES

Defense Support Communication System

Near Earth Asteroid Rendezvous

Ultra High Frequency (UHF)
BL Substrates
CPV (Terrestrial): Established players have now a manufacturing base

Emcore
Sol3g
Solar Systems Australia

Amonix
Solfocus
Concentrix
BL Substrates
LED: Commercial applications

All new cars day light running lights by 2012: EU legislation!
BL Substrates
From light bulb to light emitting diode (LED)

Ban the bulb by 2012: EU legislation!

CFL + FL: 15 tons of Hg/yr in US Landfills*

* www.lightbulbrecycling.com
Substrates in Quapaw
A state-of-the-art production plant
Substrates Quapaw

Our US plant is located in Quapaw Oklahoma

Umicore Optics Materials
= former Eagle Picher plant
= acquired in 2004
• Chemical plant
• Optics plant
• Finished Optics plant
• New Substrates plant

With internal recycling of waste streams
Substrates Quapaw
Actual IT systems in EOM

q AD is a custom built application for EOM
q Since 1990’s
q Oracle
q Revamped in 2002
q Installed in Quapaw too
q In Olen we also use SAP for some applications
q We will evolve to SAP
   Ŷ SAP is the Umicore standard
Substrates Quapaw
Production applications in EOM

- All production plants use AD
- Focus on metal accounting
  - Germanium 900usd/kg
  - Efficiency of every step
- In every step
  - Ge in
  - Ge out
- For every batch
Substrates Quapaw
Production flow substrates

- Substrates since 1990’s
- In every (sub)step
  - Ge in
  - Ge out
  - Good production
  - Scraps
- For every batch
- Risk of error
- Lots of paperwork
- AD is not so interesting for large volume production
  - Operators should focus on production and not on the administration
Substrates Quapaw

Objectives for substrates plant in Quapaw

q Operator friendly production follow-up
q Traceability wafers guaranteed
q Machine and measurement device information linked to the IT system
q Paperless office

We developed a detailed scenario
We contacted several solution providers
Substrates Quapaw
Systema proposed Eyelit as MES

- Eyelit, Canada, 1997
- MES: golden flow
  - The material is sent to a predefined next step
  - All controls and all checklists are in the MES
  - Traceability guaranteed
- AM (Asset Management)
  - Follow-up consumption of durables and consumables
  - Calibration and maintenance
- Linked with the KPI module
- With SPC module for online SPC monitoring
Substrates Quapaw
Systema links equipment to MES

- Measurement data to MES
  - via SECS GEM protocol
  - via file transfer
  - will be checked online versus the internal specs

- Systema also
  - Adapted the scenario
  - set up the MES
  - Built our MES
Substrates Quapaw

The Solus system meets our requirements

q User friendly
  ü Barcode PDA
  ü Next operation

q Paperless
  ü Everything barcode labeled
  ü Barcode reader linked to laptop
  ü High availability
  ü Online check versus specs

q Traceability
q Equipment linked
  ü Measurement data available

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### Substrates Quapaw

#### The status

- **q** System installed
- **q** Unit testing almost done
- **q** Integration testing ongoing
- **q** Set up of AM, KPI and SPC ongoing
- **q** To be done
  - ð Transfer of programming
  - ð Reporting
  - ð Go life

#### Diagram:

- **Equipment**
  - Machines
  - Measuring equipment
- **MES**
- **AD**
  - Optics
  - Warehouse
- **SAP**
  - Accounting
  - HR
  - Maintenance
  - Purchasing
Substrates Quapaw

Final comments

q Describe the scenario                July 2008
q Chose solution provider            December 2008
q Start of the co-operation with Systema March 2009
q Transfer of the solution from Olen to Quapaw October 2009
q A small team was involved:
   Ź 4 to 5 people in Olen and
   Ź 4 to 5 people in Quapaw