AMG Business Units, Products and Markets

AMG Processing
- AMG’s conversion and recycling businesses
- Niche metals & alloys
- Coating materials

AMG Mining
- Integrated AMG’s mine based businesses
- Critical raw materials

AMG Engineering
- AMG’s vacuum systems and services business
- Capital equipment & service for high purity materials

Serving the Technology Trends in Energy, Aerospace, Infrastructure, and Specialty Metals & Chemicals
Overview

- Founded in Nürnberg, Germany 1911
- Acquired by Safeguard International 1998
- Became a member of AMG 2006
- Acquired FNE Forschungsinstitut für Nichteisen-Metalle Freiberg GmbH 2007
- Celebrated 100th Anniversary 2011
- Future Growth

A leading manufacturer of high performance metals and materials

- Facilities in Nuremberg and Freiberg, DE
- 2012 Revenue: $126 million
- 2012 Gross Margin: $28 million
- 2012 ROCE: 26%
- 426 FTEs
Overview

2012 Revenue by End Market

- Aerospace 71.1%
- Energy 6.7%
- Infrastructure 3.9%
- Specialty Metals & Chem 18.8%

Operational Highlights

- Successful startup of ALD Skull Melter to improve TiAl business
  - Cold Crucible Induction Melting
- Ramp up of EcoVox plant for more independence from third party suppliers
- Increase of capacities and production efficiency
- Major steps in cost savings due to product development
- Strong growth of master alloys
- Successful renegotiations of V residue contracts
Overview

Nürnberg, Germany

Production of high performance metals and materials
- Chemicals
- Master Alloys
- Coating Materials
- Powders

Administration, Sales & Marketing, Human Resources, Accounting & IT

Freiberg / Saxony, Germany
Brand-Erbisdorf near Freiberg

Production, research and development in materials and surface technologies
- Coating Materials
- Research & Development

Other Locations

Sales & Marketing
- Wayne, PA USA
- Shanghai, China
- Worldwide network of sales partners
The EU identified 14 critical raw materials* to the European economy – focusing on two determinants – economic importance and supply risk.

## Coating Materials

<table>
<thead>
<tr>
<th>End Markets</th>
<th>Inputs and Material Science</th>
<th>Key Products</th>
<th>Value Proposition</th>
<th>Everyday Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy – Solar</td>
<td>Zn 65.4% Al 27.0%</td>
<td>Sputtering targets for TCO layers for PV thin film cells</td>
<td>Increase efficiency under subdued daylight and Reduce production costs</td>
<td>All thin film producers apply TCO with the sputtering process and ~90% of thin film TCO layers are made with ZnO:Al</td>
</tr>
<tr>
<td>Specialty Metals &amp; Chemicals</td>
<td>Si 28.1% Nb 92.9%</td>
<td>Rotatable targets for surface coating on smart phones and PCs</td>
<td>Increase visibility contrast and color impression</td>
<td>Coating layer is applied to increase contrast and color impression on iPhones</td>
</tr>
<tr>
<td></td>
<td>Al 27.0% Cr 52.0% Ti 47.9%</td>
<td>Sputtering targets for various industries such as tooling, automotive, and aerospace</td>
<td>Improve wear resistance and Provide protective hard coatings</td>
<td>Surface coatings applied to cars to improve wear resistance and UV protection</td>
</tr>
<tr>
<td></td>
<td>Al 27.0% Cr 52.0% Zn 65.4% Ti 47.9%</td>
<td>Sputtering targets and rotatable targets for the flat glass industry</td>
<td>Reduce heat loss and Increase transparency under visible light and Reduce infrared light</td>
<td>Coating layer applied on building glass to improve thermal insulation and reduce reflection</td>
</tr>
<tr>
<td></td>
<td>SiO₂, Nb₂O₅</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Coating Materials – Niobium Targets

Thin Film–Rotatable Targets for Capacitive Touch Screens

■ Increase visibility contrast and color impression on smart phones and tablet PCs
  ■ Niobium oxide rotatable targets
  ■ Rapidly growing market
■ 2010: Developed the 1st layer-stacks by DC- and MF- high-rate sputter deposition with leading coating equipment manufacturer
  ■ $ 0.3 million investment in thermal spray technology for NbO₂ and Si
■ 2011: Commercial production
■ 2012: Market leader 40% market share

Strategic Rationale

Technology and Illustration

End Markets

■ Market expected to increase 4x by 2016e
■ Market growth directly depends on implementation of new coating equipment
### Master Alloys

<table>
<thead>
<tr>
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</thead>
</table>
| Aerospace   | V 50.9 Al 27.0 | ▪ Titanium master alloys for aircraft engine components  
▪ Vanadium Aluminum (VAI) | ▪ Reduce aircraft weight, improving fuel efficiency and reducing CO\(_2\) emissions | A Boeing 787 Dreamliner contains ~250,000 lb titanium, 17% increased fuel efficiency compared to Boeing 737 |
| Aerospace   | Al 27.3 Ti 47.9 | ▪ Titanium master alloys for aircraft engines  
▪ Titanium Aluminides (\(\gamma\)-TiAl) | ▪ Provide a proprietary material and process  
▪ Reduce aircraft weight, improving fuel efficiency and reducing CO\(_2\) emissions | Titanium-aluminides are applied to blades for the last two stages of the low pressure turbine (LPT) of aircraft engines which is installed on Boeing 787 Dreamliner |
# Master Alloys – Titanium Aluminides

## Ti Aluminides for Aircraft Engines

<table>
<thead>
<tr>
<th>Example</th>
<th>Ti-64</th>
<th>Ti-6246</th>
<th>Ti-834</th>
<th>Ni-based Superalloys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature [°C]</td>
<td>up to 230</td>
<td>up to 430</td>
<td>up to 730</td>
<td>1,230 - 730</td>
</tr>
</tbody>
</table>

Titanium Aluminides up to 730
Master Alloys – Titanium Aluminides

Ti Aluminides for Aircraft Engines

Strategic Rationale

- Reducing aircraft weight to improve fuel efficiency and reduce CO₂ emissions
  - Titanium aluminides reduce weight and meet technical specifications
  - 10 year development
  - Technology: $1.2 million on VAR skull furnace developed by ALD
  - Improve availability of TiAl semi-finished goods through the skull furnace production method – both for the casting and the forging route
- 2010 first long term contract for low pressure turbine application
- Rapidly growing market due to increase fuel efficiency demands

Technology and Illustration

- Demand for aircraft engines, is growing >5% per annum for foreseeable future
- Market expected to grow by 3x by 2016e due to increase in applications

End Markets
A B787 Dreamliner contains ~250,000 lb titanium, resulting in lighter weight and 17% increased fuel efficiency compared to B737.

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</tr>
</thead>
</table>
| Specialty Metals & Chemicals | ![V](50%)| ▪ Vanadium oxides and compounds for various industries  
  ▪ SAV  
  ▪ V₂O₅  
  ▪ AMV  
  ▪ KMOV | ▪ Act as catalyst for chemical reactions  
  ▪ Protect from corrosion  
  ▪ Absorb UV and IR-light | GfE designs chemicals and powders according to customer requirements |
| Aerospace | ![V](50%) | ▪ Vanadium oxides for Titanium master alloys (for aircraft engines and components)  
  ▪ V₂O₅  
  ▪ VO₂ | ▪ Reduce aircraft weight, improving fuel efficiency and reducing CO₂ emissions | |

**Value Proposition**
- Act as catalyst for chemical reactions
- Protect from corrosion
- Absorb UV and IR-light

**Everyday Applications**
GfE designs chemicals and powders according to customer requirements.
In-sourcing Vanadium Recycling for Chemicals

- Reduce cost of vanadium and increase secure supply
- Long-term producer of $V_2O_5$ through recycling ~ 4,500 MT per year of European wastes
- Goal: Reduce costs up to $1/lb V_2O_5
  - Technology: EcoVox® for capability to reduce costs of in-house recycling
  - VO2-furnace, filter-press, a fluid-bed-dryer and a PMV facility, V2O5 furnace, a new steam generation and a waste water treatment line
- Meet or exceed all environmental specifications
- Exceed 20% of global market share

![Image of vanadium recycling process]

V2O5 Powders & Chemicals

Titanium Master Alloy (VAl)

A certified aerospace supplier for engine applications to major customers
# Powders

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</tr>
</thead>
<tbody>
<tr>
<td>Specialty Metals &amp; Chemicals</td>
<td><img src="Al.png" alt="" /></td>
<td>Industrial powders for various industries</td>
<td>Improve conductivity</td>
<td>Hip Implants coated with titanium powders</td>
</tr>
<tr>
<td></td>
<td><img src="Ti.png" alt="" /></td>
<td>- A-Cr powder hp</td>
<td>Improve biocompatibility</td>
<td>Magnets contains powders</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- CoAl 78/22 powder</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Ti-powder</td>
<td></td>
<td>Titanium powder</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- CoAlTi-powder</td>
<td></td>
<td>Pigments</td>
</tr>
</tbody>
</table>
Strategic Actions

2013

- Reduce SG&A expenses
- Improve Working Capital Levels
- Optimize CAPEX to increase ROCE

Short-term

- Improve safety and environment
- Reduce inventory and working capital
- Implement work-process optimizations
- CAPEX optimization versus budget control
- Improve cost control
- Focus on customer relations / demands

Mid-term

- Adapt capacities to meet new demand
- Re-negotiate supply contracts
- Focus on profitable product groups

Long-term

- Focus R&D projects toward future growth markets
- Develop competence centers