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Overview

AMG Critical Materials
- Vanadium
- Superalloys
- Titanium Alloys & Coatings
- Aluminum Alloys

AMG Engineering
- Engineering
- Heat Treatment Services

Tantalum & Niobium
- Antimony
- Graphite
- Silicon
Overview

- AMG Graphite is a world-leading processor of customized high-purity natural graphite with integrated mining operations to secure raw material supply
  - Processing facilities in Germany, Czech Republic, Sri Lanka and China
  - Mines in Germany, Sri Lanka, and Zimbabwe
    - Mozambique mine development project
  - 150 grades of natural graphite and 25 grades of dispersions
  - $67m revenue in 2014
  - 467 employees

- Global market for natural graphite is approx. 1.2m MT, thereof 80-85k MT are high-end grades.
- AMG’s high-end grade production is ~20k MT, representing ~25% of the global high-end market
- Alterna Capital acquired a 40% equity interest in AMG Graphite in 2015 by way of a capital increase
Value Chain

Natural Graphite Ore

~ 10,000 MT
Own Mines

~ 15,000 MT
External Sources

Processed Natural Graphite

AMG Customers

~ 25,000 MT

End Market Applications

Insulation materials
Batteries
Refractory material
Crucibles
Brake pads
Powder metallurgy
Lubricants
Strategy

AMG Graphite provides high quality natural graphite solutions through an integrated sustainable value chain serving the global market

- Partner with customers in the development of innovative graphite-based applications
  - Up to > 99.99 % Carbon
  - Flakes to Powders
  - Dispersions and Expandable Graphite

- Solidify our position as world market leader in natural graphite solutions
  - Combination of own mines and flexible market sources
  - Increase own mine capacities to 2/3 of required strategic raw material by 2020

- Grow the existing product portfolio

- Develop new products and applications in the high-end graphite markets for CO2 emission reduction, population growth and energy efficiency
Growth Opportunities

Organic Growth

Heat Insulation
- Lubricants
- Dispersions
- Expandables

Future Markets & Applications

Battery Anode Material

Graphene

Nuclear Waste Disposal Solutions
Operations
Graphite Parameters
Operations – Flow Sheet

**Mining**
- Surface & Underground

**Natural Graphite Ore**
- Flake Graphite & Vein Graphite

**Flotation**
- Increase carbon content up to 89%-96%

**Screening**
- Separation of graphite into different sizes

**Micronizing**
- Reduce particle size – “forming”

**Chemical Purification**
- Increase carbon content from +90% to 99.5%

**Thermal Purification**
- Increase carbon content from +90% to 99.98%

**Processed Natural Graphite**
- Various grades and customized solutions to the end applications
Operations – Locations

- **Kropfmühl, Germany**
  - Graphite Plant & Mine

- **Týn, Czech Republic**
  - Graphite Plant

- **Qingdao, China**
  - Graphite Plant

- **Bogala, Sri Lanka**
  - Graphite Mine

- **Lynx, Zimbabwe**
  - Graphite Mine

- **Ancuabe & Nipacue, Mozambique**
  - Graphite Mine Projects

**Map markers**:
- Green triangle: Mining facilities
- Green square: Processing facilities

[Map of global locations showing the mentioned facilities]
Markets
Market – End Markets

- Of the 1.2m metric tons per annum of natural graphite sold globally, 80-85k metric tons are high-end grades.
- AMG’s high-end grade production is ~20k metric tons, representing ~25% of the global high-end grade natural graphite products.
- China is the dominating producer and consumer.

Source: Roskill 2012 & AMG Graphite management estimates
The global graphite market is ~$14B

- Natural graphite is 9% of the graphite market with $1.3B, or 1.2m MT
- Synthetic graphite is 91% of the graphite market with $12.3B, or 1.5 MT

Source: Roskill 2012 & AMG Graphite management estimates
Energy Consumption: Natural vs. Synthetic Graphite

To produce 1 ton of synthetic graphite with similar carbon content and particle size approx. 200% more energy is needed.

Natural Graphite Summary Flow Sheet

- Mining & Crushing
- Flotation
- Purification
- Drying

Total energy required to produce 1 ton of natural graphite (approx. 99.5% carbon) is 2,500 kWh/MT.

Synthetic Graphite Summary Flow Sheet

- Crude Oil Production
- Conversion to Green Coke
- Production of Calcined Pet Coke
- Graphitization of Calcined Pet Coke

Total energy required to produce 1 ton of synthetic graphite (approx. 99.5% carbon) is 7,500 kWh/MT.
Future Markets – Battery Anode Materials

Production process for anode material

1. Natural Graphite (NG) 96%
   - $0.80-1.00/kg
   - Particle Design Purifying

2. SGB Graphite 99.9%
   - $2.00-3.00/kg
   - Coating

3. Coated SGB Graphite
   - $8.00-10.00/kg

4. Anode
   - Conductive Additive
   - Org. Binder

a. Potato Shape SGB
b. Carbon Coated SGB
c. Cross section of a coated SGB
d. Magnification of c
Graphite flake consists of thousands of graphene layers

- 3 million sheets of graphene are < 1 mm thick
- 200x stronger than steel
- Impermeable to gases and extremely high surface area
- Most stretchable crystal and is stronger than diamond
- Better conductivity than silver (both heat and electricity)

AMG Graphite’s Sri Lankan Graphite is an excellent precursor material for Graphene

AMG Graphite is producing multilayer Graphene (graphite oxide route, lab scale)

- Sales & marketing agreement with Haydale for plasma functionalized Graphene
Applications for Multi-Layer Graphene

- Barrier textiles, Absorber, Membranes
- Filled polymers/composites
- Energy storage
  - Li-Ion batteries
  - Other batteries
  - Super Caps
- Inks, anti corrosion coatings, heat / electricity conductive coatings
Securing Raw Material

Ancuabe West
View of orebody from below, looking West
The ANCUABE project

Project Ancuabe (Brownfield Site)

➢ Original plant build in 1992; production stopped in 1998

➢ Projected production of 6,000 metric tons per year (expandable to 9,000 metric tons per year)

➢ Investment of approx. $10 Million

➢ Operations to commence in Q2 2016

➢ Workforce of approx. 120 employees

➢ Social projects initiated and ongoing e.g. School & Kindergarten, Agriculture & Herbal Medicine Center

➢ Vocational technical training center for welders and electricians planned

➢ Secured and in final contracting stage for project financing with banks
The NIPACUE project

Project Nipacue (Greenfield Site)

- Status: Exploration and Pre-Feasibility
- Graphite deposit (JORC): > 900,000 metric tons
- Potential commencement of operations from 2020 onwards
- Following completion of the ANCUABE project, focus will be on the evaluation and further development of the feasibility study of project NIPACUE.
Performance – AMG Graphite 2010 - 2014

Revenues in €k
Value Creation

➢ Organic Growth
  • Strong growth through 2020 with existing product portfolio
  • Increase market share and product offerings
    • Heat insulation
    • Lubricants and dispersions

➢ 2015 Operational Objectives
  • $10m investment in the Ancuabe mine in Mozambique
  • Develop graphite products & technologies for e-mobility
  • AMG Graphite & Haydale Graphene product testing at customers laboratories