The Global Titanium Market and the European Challenge

Dr. Holz will provide an overview of the European Titanium industry as a vibrant global marketplace. His focus on industrial applications will address those major market segments where the business (plates and tube), though erratic, is mostly concentrated – power generation (strong need for construction/revamping of energy plants), PHE (booming market) and desalination (fast-growing demand worldwide). Emphasis will be placed on the number of projects that are supplied by European fabricators.

The presentation will also address military and civil aerospace - where Europe is well represented by Airbus with the A400M and A380 respectively - which appear a most challenging business (continuing to boom) as well as a very sensitive barometer of the world economic development that gages the excellence the titanium industry is successfully pursuing.
The Global Titanium Market and the European Challenge

Dr. Markus Holz
ThyssenKrupp Titanium
The Global Titanium Market and the European Challenge

- Market Overview
- Challenging Market Environment
- Outlook and Summary
European Civil Aerospace

Threat:
Declining passenger numbers caused by:
• increased taxes and fees
• record-high fuel cost
• GDP reduction in Europe
• weakening global economy
• noise and Co₂ emissions

Production problems
• Airbus A 380 18 months delay
• Boeing 787 20 months delay

Possible consequences:
• Airline market will be re-shaped
• Airlines could cancel or postpone orders for new aircrafts
• Non exercising of current options
Civil Aviation Worldwide

Total per passenger-kilometer (billions)

<table>
<thead>
<tr>
<th>Year</th>
<th>ALITALIA</th>
<th>OLYMPIA AIRLINES</th>
<th>IBERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2000</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Declining passenger numbers

- ALITALIA: -25%
- OLYMPIA AIRLINES: -14%
- IBERIA: -10%

Prognosis before the fuel price shock

Possible new scenario

Source: Boeing, AEA, IATA

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ThyssenKrupp Titanium
# European Civil Aerospace

## Airbus Situation

### Airbus Order Portfolio as of 09/01/08

<table>
<thead>
<tr>
<th>Model</th>
<th>Number of Aircrafts</th>
</tr>
</thead>
<tbody>
<tr>
<td>A318, A319, A320, A321</td>
<td>2725</td>
</tr>
<tr>
<td>A330, A340, A350</td>
<td>935</td>
</tr>
<tr>
<td>A380</td>
<td>186</td>
</tr>
</tbody>
</table>

**Order backlog aircraft:** 3846

**More than 5 years**

*Total titanium demand: ~ 100,000 to*
Airbus Titanium demand according to projected airplane deliveries 2008 to 2020 (by weight / mill products)

* It is assumed that there will be a new Airbus single aisle family beginning in 2018.

This has a significant impact on the titanium demand.

Source: THE AIRLINE MONITOR/own research

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Lower Titanium Consumption by AIRCRAFT

Build-rate reduction

Short Term Difficulty B 787 and A 380 delayed – 18000 MT more material in cycle

Production Planning Boeing B 787

Production Planning Airbus A 380

Source: Boeing, Airbus, THE AIRLINE MONITOR
Estimated Lower Titanium Consumption by AIRCRAFT Build-rate reduction (A380 + B787)

Titanium Demand Actual vs. Plan

<table>
<thead>
<tr>
<th>Year</th>
<th>Ti demand actual</th>
<th>Ti demand plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>146</td>
<td>11.744</td>
</tr>
<tr>
<td>2008</td>
<td>1.168</td>
<td>9.408</td>
</tr>
<tr>
<td>2009</td>
<td>2.044</td>
<td>11.744</td>
</tr>
</tbody>
</table>

Assumption of TKL-TI

Demand vs. Actual supply 18.900 tons Ti semis

2007 2008 2009

Krupp

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Products that are mainly directly affected by lower Ti consumptions by aircraft

- INGOTS
- LONG PRODUCTS
- GR. 5 PLATES

Approximately 40% of titanium world demand

Source: own calculation
Industrial market still demanding

- **Stable growth** ⇒ Tube & Shell Heat Exchangers
  - 2008 = 8,800 t
  - 2015 = 10,400 t

- **Rapid growth** ⇒ Plate Heat Exchangers
  - 2008 = 6,100 t
  - 2015 = 10,400 t

- **Stable growth** ⇒ Medical
  - 2008 = 2,200 t
  - 2015 = 3,000 t

- **Rapid growth** ⇒ LNG Trade expected to expand 4-fold till 2030
  - Ti demand 250 t/plant
  - Ti demand 20 t/LNG carrier
  - Order backlog LNG carrier: 140

- **Rapid growth** ⇒ Nuclear Power Plants
  - 62 NPP in planning
  - Ti demand 2010–2012 = 4,000 t/year

Source: own market research, IEA
Titanium demand for liquified natural gas LNG (1)

Demand for transportation of LNG is increasing rapidly.

World gas consumption in 2007
= 2850 billion m³

Local consumption: 84 %
Transportation by pipeline: 12 %
Transportation by LNG tanker: 4 %

Gas transportation <= 3200 km = pipeline
Gas transportation >= 3200 – 8000 km = LNG tanker

Source: Siemens, High Performance Tube
Titanium demand for liquified natural gas LNG (2)

LNG trade is expected to increase 4 times

World gas consumption 2007 = 2850 billion m³
2030 = 4275 billion m³

LNG in 2007 = 4 %
LNG in 2030 = 16 %

Titanium demand for LNG
LNG plant: 250 to
LNG tanker: 20 to

Source: Siemens, High Performance Tube

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Titanium demand for nuclear power plants (NPP)

2007 = 442 NPP in operation
2007 = 28 NPP under construction
2007 = 62 NPP in planning

Next 15 years = 160 NPP in planning

<table>
<thead>
<tr>
<th>Country</th>
<th>Under construction</th>
<th>Final planning</th>
<th>Total demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>7</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>China</td>
<td>5</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>Russia</td>
<td>4</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>USA</td>
<td>1</td>
<td>-</td>
<td>13</td>
</tr>
<tr>
<td>South Africa</td>
<td>-</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>South Korea</td>
<td>-</td>
<td>8</td>
<td>-</td>
</tr>
</tbody>
</table>

Titanium demand for NPP:
2010 – 2012 = 4000 to/year

Source: Valtimet

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Seawater desalination I

Installed seawater desalination capacity will increase by 16% per year.

Titanium demand depends on the size of the desalination plants (thermal process).

Characteristic plant capacities and titanium requirements are:

- 240,000 – 270,000 m³/day drinking water output: 70 t titanium
- 800,000 m³/day drinking water output: 400 t titanium

* Thermal processes
Source: own interviews/research
Seawater desalination II

- Demand growth in the last 70 years
  - Water consumption: 6-fold increase
  - World population: 3-fold increase

- Consumption of available fresh water
  - today: 50%
  - in 2025: 70%

- Driving force
  - Rising consumption in Middle East
  - China will become an important market for desalination plants, due to rising water demand.

Source: own interviews/research
World Medical Market (I)

Medical Market by application

- Hip joints: 36%
- Knee joints: 40%
- Extremity: 4%
- Denture: 20%

Source: Zimmer
World Medical Market (II)

The orthopaedists use 2.2 Million different orthopaedic part of titanium

World titanium demand by medical application in 2007

- Spinal columns: 340 t (16%)
- Denture: 450 t (20%)
- Implants: 1,150 t (52%)
- Surgical instruments: 90 t (4%)
- Others: 180 t (8%)
- Total: 2,210 t

Source: Smith & Nephew, Zimmer

World Medical Market by Region

USA: 50%
Europe: 25%
Asia: 22%
Others: 3%
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European Titanium Industry: The main challenge

• Price pressure by higher availability of more material due to aero crisis

• Projects delayed due to financial crisis of world economy
Price/Cost Hysteresis of Cyclical Businesses

Market prices

Raw material costs

2005-2008

2008-20XX

Price/Costs Development

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ThyssenKrupp Titanium
Europe Terms and Trade
Worldwide supply routes for titanium mill products

Russia exports mainly to the USA and Europe (=Boeing und Airbus). Japan supplies the industrial markets in Europe, China and Korea. The USA supplies the European aviation market.

Titanium mill products: The main importers and exporters (2007)

EUROPE IS THE BIGGEST NET IMPORTER OF TITANIUM MATERIAL WORLDWIDE

European Titanium Industry: Strategic Position

Production, consumption of titanium by regions (2007)

<table>
<thead>
<tr>
<th>Region</th>
<th>USA</th>
<th>Japan</th>
<th>China</th>
<th>Russia</th>
<th>Kazakhstan</th>
<th>Ukraine</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>9%</td>
<td>32%</td>
<td>5%</td>
<td>28%</td>
<td>20%</td>
<td>6%</td>
</tr>
<tr>
<td>2007</td>
<td>9%</td>
<td>24%</td>
<td>28%</td>
<td>20%</td>
<td>14%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Value chain, products

Titanium sponge production

Titanium mill product shipments

Titanium mill product markets

Titanium user markets

Source: own research/-interviews/-calculations

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Europe is the 2nd scrap generator worldwide

Titanium scrap production by regions (2007)

**USA**
- Large volumes on mill scrap and aerospace process scrap

**Japan**
- Mainly mill scrap due to large exports of mill products

**Europe**
- Small mill scrap volumes (small mill production) but large aerospace process scrap volume

Remarks

- USA: Large volumes on mill scrap and aerospace process scrap
- Japan: Mainly mill scrap due to large exports of mill products
- Europe: Small mill scrap volumes (small mill production) but large aerospace process scrap volume

Source: AMCG-research/own calculations/-interviews
Consequences for ThyssenKrupp as a major European Titanium producer

- Using internal raw material/scrap by electron beam melting
- Improving downstream
  - Sophisticated melting processes
  - New forging press
  - Ti dedicated plate mill
  - Ti optimised cold rolling line
  - Ti dedicated VCF
  - Ti optimised tube lines
Electron beam cold hearth melting

E-Beam distribution on the Hearth/Crucible Assembly

Typical General Lay Out

Zero level

Sub level

Source: ALD
EB-Furnace

15 MT

Targets of Investment

- Quasi continuous melting
- Single melting of ingot or slab in large geometrical dimensions
  → Reduction of production steps; increase of yield
- Usage of entire variety of sponge to scrap raw material, depending on price

17th of March '08
first slab produced
VCF – Vacuum Creep Flattener

Capacity: 700 tons
Plate thickness: 3-150 mm
Inauguration: Oct. 2006
ThyssenKrupp VDM -DIVISION FORGING-

40/45 MN Forging Press

- YOB: 2007; SMS Meer, Germany
- open die forging press
- 2 manipulators
- 4 column design (pre stressed)
- 4 sides flat guiding system each column
- daylight 4300 mm
- width between columns 3125 mm
- max stroke rate 120 min⁻¹
- penetration speed 120-170 mm/s
TK Aerospace, operating from 30 service centres in 13 countries throughout the Americas, Europe and Asia Pacific, has been created to provide their customers with

- More choice
- More value for money
- More market coverage
- More options
- More experience
The Global Titanium Market and the European Challenge

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Outlook and Summary

- Reduce sponge requirements by using scrap at a maximum
- Reduce dependence on imports by enlarging fabrication capacity
- Verticalization of manufacturing process / increasing service

Improving performance and services to the European Titanium consumer in a more difficult market environment.
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Guarantees in respect of the existence of certain properties or utilization of the material mentioned are only valid if agreed upon in writing.
Thank you for your attention!