Innovation in the Era of Delivery

Titanium USA 2016

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September 26, 2016
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Safe Harbor Statement

Forward-Looking Statements

This communication contains statements that relate to future events and expectations and as such constitute forward-looking statements. Forward-looking statements include those containing such words as “anticipates,” “estimates,” “expects,” “forecasts,” “goal,” “plans,” “potential,” “should,” “will,” or other words of similar meaning. All statements that reflect Alcoa’s expectations, assumptions, or projections about the future other than statements of historical fact are forward-looking statements, including, without limitation, statements regarding the potential and future for the RSR joining system. Forward-looking statements are subject to risks, uncertainties, and changes in circumstances that are difficult to predict and are not guarantees of future performance. Important factors that could cause actual results to differ materially from those in the forward-looking statements include: (a) material adverse changes in aluminum industry conditions; (b) unfavorable changes in the markets served by Alcoa, including the automotive, commercial transportation, and other markets; (c) failure to advance or successfully implement, to achieve commercialization of, or to realize expected benefits from, new technologies or innovative products, including, without limitation, the RSR joining system, whether due to changes in the regulatory environment, competitive developments, or other factors; (d) the impact of the separation on the businesses of Alcoa; and (e) the other risk factors discussed in Alcoa’s Form 10-K for the year ended December 31, 2015 and other reports filed with the Securities and Exchange Commission. Market projections are subject to the risks discussed above and other risks in the market. Alcoa disclaims any intention or obligation to update publicly any forward-looking statements, whether in response to new information, future events or otherwise, except as required by applicable law.
Alcoa’s aerospace businesses will be a key component of Arconic following Alcoa’s separation. Arconic will be a premier innovator of high performance, multi-material products and solutions in attractive growth markets, including aerospace.

Arconic Company Profile

- Includes Engineered Products and Solutions (EPS); Global Rolled Products (GRP); and Transportation and Construction Solutions (TCS) segments
- Positioned to grow profitably - innovation leader with full pipeline of products and solutions
- 41% of 2015 revenues tied to high-growth aerospace industry

Market Positions

- EPS: 82% of aerospace revenue generated by materials other than aluminum
- #1 or #2 market positions in five key businesses – Aerospace, Automotive, Commercial Transportation, Industrial Gas Turbines (IGT), Building and Construction (B&C)
- EPS: Differentiated supplier to high-growth aerospace industry with leading positions on every major aircraft and jet engine platform

Arconic will launch in 2016.
Then: The Era of Design

The last decade was all about new designs and product technology.

**Start of Decade:** Design decisions were unsettled:
- A320 and 737 replacements?
- 767 / 757 replacement?
- A330 replacement?
- 747-400 and A380 evolution?
- 777 evolution?
- Chinese and Russian entrants?

**End of Decade:** An unprecedented number of recently or soon-to-be introduced models:
- The A320neo and 737MAX
- The A330neo
- The 787 and A350-XWB
- The 777-X
- The CSeries
- The C919
- The MS-21
- E-2s, MRJ, ARJ-21 & SSJ-100
Commercial Jet Delivery & Backlog Development

Thanks to an unprecedented level of new model introductions the order book stands at nine years of production at 2015 delivery rates.

Now the focus shifts:
- **From**: Can we generate orders?
- **To**: Can we profitably deliver?

Source: The Airline Monitor
2015-2020 Aerospace Raw Material Demand

Aerospace raw material demand is expected to grow by **0.9% per annum**

- Overall raw material demand growth will be lower than aircraft unit growth due to lower buy-to-fly ratios and greater use of composites.
- Composites and titanium continue to be the fastest growing material categories while aluminum demand will decrease slightly.

Titanium and Composite Usage Increasing in New Aircraft

Source: Sanford Bernstein & Company, 2016

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Titanium Shipments to Aircraft Market

Source: Northcoast Research, 2015

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Commercial Jet Titanium Mill Products Growth 2014-2019 and Titanium Growth Content in Next-Gen Aircraft

Aircraft Mix Changes
Platform titanium buy weights (000lbs) for select aircraft

Drives Growth in Titanium
Titanium Mill Products Spend (1) for Commercial Jets (2) ($B)

Source: ICF International
1) Buy weight value for billet, bloom, plate, sheet, bar;
2) Includes large commercial jets and regional jets

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Now: The Era of Delivery

A limited number of new starts expected; this shift affects every dimension of the industry

- **Cost-Down Initiatives:** Such as Boeing’s “Partnership for Success”
- **Geography:** Increasing amounts of sourcing from low-cost / emerging countries
- **Trade-Offs:** Cost considerations favored over obtaining that last bit of incremental performance
- **Procurement Practices:** Supplier consolidation and material / contractual “aggregation”
Innovation, Engineered

We are ushering in the “Era of Delivery” through innovation in four key areas.

1. Materials Science
2. Advanced Manufacturing Technologies
3. Design Optimization
4. Qualification Expertise

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Titanium Fine Grain Sheet

Fine Grain, Low Temp SPF Ti 6-4

- Process for making fine grain sheet for Ti 6-4 established
- 200F (93°C) lower forming temperature = longer tooling life + thinner gauges can be used with deeper draw
- Diffusion bonds easily to other alloys
- Can replace complicated welded shapes with a single formed shape
- Ti 6-4 sheet in production and Ti 6-2-4-2 being evaluated
Near Net Shape Extrusions

**Phased approach to cross section reduction**

- Proven phased approach to reduce cross sections
- Development of ATEP proprietary technology for producing very-near-net shapes (VNNE)
- Reduced residual stress enables tighter machine stock conditions and stable machining setups
- Process improvements to optimize extrusion length and stretch cycle
- OEM collaborations to expand formed-extrusion capabilities

**Metal Efficiency / Machining Gains**

- >50% metal savings

**Conversion Cost Improvements**

- Arconic will launch in 2016.
Additive Manufacturing: Our Comprehensive Approach Is Feeding Value Streams

Paths to value creation in additive manufacturing

1. **End Product**
   (Direct & Hybrid Manufacturing)
   - Finished AM metal parts
   - Alcoa Ampliforge™
   - Net and near net shaped parts

2. **Rapid Prototyping & Tooling**
   (Indirect Manufacturing)
   - Rapid tooling & fixtures
   - Dies and molds
   - Manufacturing productivity

3. **New Material Discovery**
   (Materials legacy applied to feedstock development)
   - Metal powder/wire
   - Ceramic/MMC, Resin
   - Enhanced properties
   - Combine materials in a single part

**New, Tougher, Stronger Parts**

**Increased Production Speed**

**New Materials and Properties**

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Additive Manufacturing: Proprietary Metal Powders

Optimized for 3D-Printing

- Metal powders used for 3D printing durable, high-quality aerospace parts are available in limited quantities
- Developing materials with novel properties, such as rapid solidification, needed to 3D print high-performance components
- Titanium, nickel, aluminum and cobalt alloys
- Engineered specifically for AM producibility; example – morphology impact on process and properties
- Builds on more than a century of experience in metal alloy development and metal powder production
Additive Manufacturing: Hybrid Ampliforge™ Technology

Proprietary technique combines additive and advanced forging technologies for enhanced properties of 3D printed parts.

3D Part Design → 3D-printed part to near completion → Forging for enhanced properties → Finished part

- Reduced materials input
- Simplified production
- Improved fatigue and strength
- Nearer-net forgings

Ampliforge™ Ti Pylon Component

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Hybrid AM Technologies for Engine Cases

Disruptive utilization of hybrid (AM+ machining) technologies to produce near finish cases

Current flow path
- Ingot/Billet
- Semi Finished Ring
- Subtractive Machining
- Finish Processes

Hybrid AM path
- Ingot/Billet
- Thinner Semi Finished Ring
- Boss/Flanges added by AM (wire)
- Finish Processes

High pressure compressor case with a complex pattern of bosses and flanges

Benefits
- Reduced cost
- Reduced lead time
- Increased flexibility
- Reduced buy-to-fly ratio 15:1>3:1

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Additive Manufacturing: Product Design and Qualification

Critical to understand how AM fits the design

Design for the AM Process:
- Design optimization - crowdsourced design to leverage global engineering expertise
- Material optimization
- Build analysis and optimization tools
- Cost analysis

Qualification Requirements:
- Process verification techniques
- Inspection processes
- Customer collaborations
- Engagement with certification

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**Ultrasound**
- Discontinuity Detection
- Build Feature Identification

**Radiography**
- Void Analysis
- 3D Computed Tomography

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The Era of Delivery

Arconic is laser-focused on the materials and process innovations needed to deliver the next generation of commercial aircraft.

- The aerospace market outlook remains positive
- Industry focus is shifting from order generation to profitable delivery
- The market is ripe for innovation in materials and processes