

How Materials Science Matters: Breakthroughs in Buy-to-use for Aeronautics

Kevin Kramer, Senior VP – Chief Commercial & Marketing Officer 13 June 2019

Relentless Innovation°

© 2019 ATI. All rights reserved.

Introducing Allegheny Technologies Inc. – ATI

Who We are

Global manufacturer of technically advanced specialty materials and complex components focusing on advanced specialty materials technologies with unsurpassed manufacturing capabilities.

We're solving the world's most difficult challenges through materials science...



... and Relentless Innovation®

Strong Positions, Strong Markets



Creating Long-Term Value



2018 Revenue: **\$4.05 Billion** Net Income attributable to ATI: **\$222 Million** International Sales: **42%**



57 Locations in 17 Countries

- USA: 36
- Europe: 9
- Asia: 12



~8,500 employees focused on delivering value every day



Nearly half ATI's sales to aerospace and defense







Megatrends Driving Aerospace Markets

Global economic growth fueling increased demand for aircraft



Global GDP Growth¹

• Estimated 2019 world GDP of 2.9%, stable versus 2017 at 3.1% and 2018 est. at 3.0%

Increasing Air Traffic²

- Passenger traffic remains strong; 2018 revenue passenger kilometer (RPK) growth of 7.0% building on 8.1% growth experienced in 2017
- Airfreight demand growth continues, 2018 freight tonne kilometers (FTK) expand 3.5% in addition to robust 2017 growth of 9.7%



Aircraft Demand

- Emerging markets continue to show growth and stability, led by Asia Pacific and Middle East North Africa
- Airframe & engine backlog of approximately 7 years

Production Rates

• New program production ramp-up rates impacted by design and supply chain challenges





Advanced materials enable fuel efficiency, lower emissions

Materials science solving the most difficult aerospace challenges

Ni Superalloy Powder & Isothermal Forging contributes to:

- 15% improvement in fuel efficiency
- \geq 15% reduction in CO₂ emissions
- 75% reduction noise footprint

Titanium enables:

- Broader use of composites in aero-structures
- Further light-weighting of planes: Ti has 2X the specific strength as steel

TI advanced materials enable aero-engines to run hotter and more efficiently



CFM LEAP







Pratt & Whitney 1100G GTF





Digital metal enables smarter manufacturing

Modeling significantly increases right-first-time rate



Modeling enables:

- Tailored microstructure, leading to enhanced performance
- Reduced part count
- Cycle time reduction: Days/weeks vs. Months/years required by physical trials
- **Increased fidelity:** Finer meshes enabled by increased computing power—1 trillion times more powerful than 1950s—allow more and more complicated simulations leading to more complex parts





Start-to-Finish Additive Manufacturing: Design to Final Part

Additive Manufacturing for aerospace parts can reduce material usage by up to 60-80%

Business Case for Additive

- Complex parts: Nickel, Titanium
- Low volume
- Long lead times for traditional manufacturing







Designed for Manufacturing

- Enhanced internal features
- Combined assemblies
- Reduced part count

Process Development

- Material selection
- Process parameter strategy
- Post Processing

Concest Transford



Picture Source: NASA

Finished Component

- Lighter weight
- Superior temperature
 resistance





Metals Sustainability: Recycling reduces energy by 90%

Use of revert and recycled over virgin materials reduces costs







As hybrids lead aero-electrification, battery storage is key

Materials science key to improved battery performance



Improved battery performance driven by need to store more charge per volume (e.g. improved cathode, anode, and electrolyte materials)

- Improved charge density
- Lighter weight/More compact
- Corrosion resistant components
- Novel battery chemistries and processing
- Surface chemistry and morphology

ATI materials are used extensively in the nuclear, fossil and renewable energy industries to resist the most demanding high temperature and corrosive environments.



Accelerating aerospace capabilities

Looking ahead at the future of aerospace

Aerospace continues to accelerate:

- Increasing demand for commercial air travel
- Airframe/engine builds strong over next decade

Demanding increased capabilities

- Hybrid/electric engines will demand multimaterials solutions
- Battery storage technology will be a key to e-flight



Resulting in innovative materials solutions

- Driving demand for multi-materials solutions
- Leveraging battery technology from adjacent industries (e.g. energy, automotive)
- Public and private policy initiatives crucial to sustainable growth: metrics to track progress, opportunities to monetize results



