Towards a step change in the economics of titanium alloys for the automotive sector

Challenges and innovations in Automotive Engineering
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The AMRC Knowledge Transfer Centre

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Titanium alloy usage today
Current processing of titanium alloys


Development of disruptive solid-state powder manufacturing technologies.
**Researchers**

- **Dr Luke Marshall:** Designing novel Ti alloys for continuous rotary extrusion
- **Dr Ben Thomas:** Continuous extrusion of Ti alloy powder into wire/springs
- **Mark Richardson:** Property evolution during forging of near beta Ti alloys
- **Nick Weston:** Exploitation of spark plasma sintering of Ti alloy powders
- **Graham Richards:** Alpha case formation in Ti-6-4 alloy sheet during DBSPF
- **Oliver Hatt:** Tool/workpiece interactions during machining of Ti alloys
- **James Pollard:** Texture prediction during direct extrusion & HT of Ti alloys
- **Adam Cox:** High performance machining & fatigue of beta Ti alloys
- **Lyndsey Benson:** Direct reduction of novel Ti alloys from synthetic rutile
- **Emma Calvert:** Development of forging & aging of Ti alloys from powder
- **Maureen Aceves:** Micro-milling of alpha Ti alloys for surgical instruments
- **Jacob Pope:** Diffusion bonding & CRF of Ti alloy powder preforms
- **Nayden Matev:** Fatigue limiting damage during machining of Ti alloys
- **Sarah Smythe:** Continuous extrusion of Ti powder into WAAM feedstock

**Industry Sponsors & Collaborators**
Low cost titanium alloy projects

1. Production of titanium alloys directly from rutile

2. **TWISTER**: Titanium Wire for Innovative Spring Technologies and Emissions Reduction

3. **FAST-Forge**: From rutile sand to novel titanium alloy aerospace component in 3 steps
Low cost titanium alloy projects

1) Production of titanium alloys directly from rutile using the FFC process

Low cost titanium alloy developments

2) **TWISTER**: Titanium Wire for Innovative Spring Technologies and Emissions Reduction

[Diagram and images of TWISTER process and titanium wire]

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**Thomas, B.M.,** Derguti, F., Jackson, M.; UK Patent Application No.1421818.4
- Manufacture of metal particles (Ti Continuous Rotary Extrusion).
Low cost titanium alloy developments

Titanium Today, July 2013

November 2011
3) **FAST-Forge** – From rutile sand to novel titanium alloy aerospace component in 3 steps

**STEP 1:**
- Alternative Extraction Method
  - Rutile Ore
  - Titanium Alloy Powder

**STEP 2:**
- Shaped Field Assisted Sintering Technology
  - Optimised Shape Preform Billet

**STEP 3:**
- One-Step Forging
  - Near Net-Shape Component
Low cost titanium alloy developments

Low cost titanium alloy developments

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<th>Sample Type</th>
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<th>UTS (MPa)</th>
<th>Elongation (%)</th>
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- Tests conducted to ASTM E8-15a by Special Testing Ltd.
- Round samples machined from bulk FAST disc with axial orientation and 16 mm gauge length x 4 mm cross-sectional area
Low cost titanium alloy developments
Low cost titanium alloy developments

950°C 0.1s⁻¹

Centre  Intermediate  Edge

Shaped FAST

Bulk FAST

Compression Direction

50 µm  50 µm  50 µm

Load (kN)  Displacement (mm)

- 850°C - NNS FAST
- 950°C - NNS FAST
- 1050°C - NNS FAST
- 850°C - Bulk
- 950°C - Bulk
- 1050°C - Bulk
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