FAST STEP 3

Titanium Swarf to Engine Components in 3 steps

Thursday 5th September 2019
Cenex Low Carbon Vehicle Event

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Vision

- To utilise high-value titanium alloy swarf as a feedstock for the FAST and FAST-forg processes
- To generate near-net-shape components with the high strength & good fatigue life typically required within an automotive engine
- An indication of production volume capability and cost levels for the automotive industry
- The development of a new UK supply chain, resulting in growth opportunities:
  - Niche vehicles to higher volume applications
  - Other sectors such as off-shore, rail, aerospace, non-auto engine, defence & low-cost desalination
# Partners & Scope

<table>
<thead>
<tr>
<th>Partner</th>
<th>Company Description</th>
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<tr>
<td>Bentley Motors Ltd</td>
<td>Manufacturer of luxury performance automobiles for world-wide markets.</td>
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<tr>
<td>Force Technology Ltd</td>
<td>Provision of advanced design, development, manufacture &amp; test for advanced spring solutions. Automotive Tier 1 status with IATF 16949 certification, but also supply into other sectors.</td>
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<tr>
<td>WH Tildesley Ltd</td>
<td>Specialist supplier of forged &amp; machined components to a wide range of markets.</td>
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<td>Transition International Ltd</td>
<td>Bespoke manufacturer of Ferro-Titanium from titanium scrap to meet specific customer requirements.</td>
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<td>Northern Automotive Alliance</td>
<td>Independent, not-for-profit, organisation providing support for all companies within the automotive sector within NW &amp; Yorkshire.</td>
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<tr>
<td>University of Sheffield</td>
<td>Department of Materials Science &amp; Engineering is one of the top materials departments in the UK with a long history in metallurgy. Part of the Faculty of Engineering, which is ranked 1st in the UK for research income, and 1st in the UK for industry focused R&amp;D.</td>
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Overall Project Outcomes

- Manufactured & functional bench test 4 components
- Process mapping & understanding of process variability, limitations & opportunities for swarf cleaning & grading
- FAST tooling & process development
- Forging tooling & process development for FAST near-net shape preforms
- Finishing processes for ready-to-supply components
- Development of the business process for a supply chain for supply into OEMs.
Overall Project Outcomes

Sep 18 – May 19
Swarf Definition

Apr 19 – Feb 20
Retainer

Jul 19 – May 20
Piston Pin

Oct 19 – Dec 20
Rocker Arm

Apr 20 – Jul 21
Con Rod

Aug 21
Final report & Close-Out

FAST STEP 3
Lowering the Cost of Titanium

The Need for Cost-Effective Downstream Processing

The buy-to-fly ratio of titanium alloys for the F-22 is over 12:1[2]

- 45 of the 50 tonnes purchased per aircraft is turned into scrap – mostly as machining swarf/chips

Cost Breakdown of Producing 25 mm Thick Ti Alloy Plate [1]

- 2nd Melt: 3%
- 1st Melt w/ Alloy: 12%
- Chlorination: 9%
- Rutile: 4%
- Mg Reduction: 25%

Cost of Ingot

- Thermomechanical Processing: 47%

Cost of Processing


Lowering the Cost of Titanium
The Need for Cost-Effective Downstream Processing

To achieve a true step-change in the economics of titanium components it is necessary to combine lower-cost powder/particulate feedstocks with novel solid-state processing.
Novel method of **controlled rapid sintering** to produce **full density** specimens that is faster and more flexible than other powder metallurgy methods.

Simultaneous application of **uniaxial load and electric current**, which causes Joule heating.

Consensus is FAST offers **technological/economic advantages** over conventional sintering techniques.
The FAST-forg Concept
From titanium alloy feedstock to forged component in 2 steps

FAST STEP3 Programme 2018-2021

Field Assisted Sintering Technology for Swarf Titanium to Engine Parts in 3 Steps

STEP3 will utilise Ti alloy swarf as feedstock for FAST and FAST-forg to produce near-net-shapes that will be finish machined to produce components with the high strength and good fatigue life typically required within an automotive engine.
The Future

Integrating with Royce@Sheffield

The UK National Institute For Advanced Materials Research and Innovation

- A Different Kind of Research Institute; Open to Industry, Academia and the Public.
- Offering industry and academia the capability to make, test and characterise materials, components and systems; over £150m of equipment is available, easy to access and technically supported.

Royce@Sheffield is part of the Department of Materials Science and Engineering.

- As a major partner of the Henry Royce Institute, we are leading on the theme of Advanced Metals Processing
- www.sheffield.ac.uk/materials/research/centresandfacilities/royce

Royce@Sheffield has purchased an FCT Systeme Model HP D 250/C FAST furnace.

- Additional cooling chamber allows semi-continuous processing of parts up to 250 mm diameter
- Unique capability within the UK
- Will be utilised by FAST STEP3 project from mid 2020

FAST STEP 3
The Future

- Watch for progress on our website:  
  - WWW.FASTSTEP3.ORG.UK

- Come back and see progress next year

- Come and talk to us if you have an interest in being part of our next phase, or take a leaflet
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