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Introduction
Metalysis background

• Based in South Yorkshire in the UK, currently around 40 employees

• Metalysis has developed a unique technology originally based on the FFC® Process invented at the University of Cambridge, UK

• The technology is capable of producing a vast range of metal powders for use in conventional and additive manufacturing at substantially lower cost

• Capable of producing metals for a range of niche and volume markets, including aerospace, electronics, biomedical, petro-chemical and automotive

• Based on 10 years of R&D effort Metalysis has built a small industrial facility in the UK to demonstrate tantalum & titanium production

• 25 live, published families of patents originally based on the FFC® approach – substantially developed

• Iluka resources have recently invested £12m into the company for development of Ti powders for additive manufacturing
• Electrolysis processes are regarded as highly efficient
• Relatively low temperature operation and lower energy consumption
• Inexpensive components for electrolysis – cheap, readily available salt and carbon
• No toxic gases used
• Powder feed to powder product
Background - disruptive impact across periodic table
Combining elements through powder metallurgy to create novel alloys opens up new possibilities for markets and applications

The Metalysis process can be a key enabler for this process
Background – initial focus on two core products

- Metalysis has chosen to focus initially on two metals, tantalum and titanium
- Tantalum is the initial entry market as it is specialist, low volume and high margin

PHASE 1:
- High value metal - annual volumes of 2,500 tonnes in a market worth over $2 billion
- Powder prices range from $500 – 2,000/kg
- Mainly produced by the Hunter process
- Substantial margin opportunities – a viable business in its own right
Background – initial focus on two core products

- Metalysis has chosen to focus initially on two metals, tantalum and titanium
- Tantalum is the initial entry market as it is specialist, low volume and high margin
- Titanium is a larger market which could be transformed by the introduction of a low-cost production process

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**PHASE 2:**
- High value metal - annual volumes of ~170 ktpa in a market worth over $10 billion
- Powder prices range from $200-400/kg
- All titanium is produced by the Kroll process
- Current market size is constrained by the cost of the metal, poised to expand rapidly if the cost can be lowered
- A significant value opportunity
• 25 live, published families of patents originally based on the FFC® approach – substantially developed

• Patents cover all aspects of the process from feedstock, preparation of the oxide, reduction parameters, cell design, post processing and bespoke ancillary services

• Core patent has been filed in over 50 countries

• Combined IP now inclusive of portfolios from
  – Cambridge University - FFC®
  – Qinetiq -EDO ®
  – BHP Billiton – Polar ®
  – Metalysis

• A suite of next generation patents filed that deliver extended IP protection
Background – current investors

www.chordcapital.co.uk
www.etf.eu.com
www.bhpbilliton.com
www.sevenspires.co.uk
www.djespirit.com
www.lluka.com
Iluka Resources

- Market capitalisation of ~$4 billion
- One of the top 5 Australian resource companies
- Operations in Australia and the US
- Largest producer of zircon in the world, 30% market share
- Second largest producer of titanium dioxide minerals

Source: Iluka Resources
Phase 2 – Global titanium markets

- High value metal - annual volumes of ~170,000 tonnes in a market worth over $10 billion
- The market for additive manufacturing is currently worth over $1 billion and is growing at 20% CAGR. The market for powders is expected to grow to ~$30 billion by 2025
- Additive manufacturing grade titanium powder prices range from $200-400/kg
- Target markets for titanium powders
  - Aerospace grade
    - Demand from the aerospace industry remains strong due to use of composites and drive for fuel efficiency
    - Metalalysis has developed a unique powder product derived directly from either a ore feedstock, or high grade ‘pigment’ sources
  - Industrial grade
    - Used in the petrochemical, desalination and medical industries
    - Current market size is constrained by the cost of the metal, poised to expand rapidly if the cost can be lowered
- A significant value opportunity

Source: Roskill, ITA, SMR
Halving the price of aluminium has generated at least a ten-fold volume growth for aluminium.

**Source:** USGS, European Aluminium Association
Titanium ore $0.6/kg

$TiCl_4$ $1.5/kg

$Kroll$ sponge $11-15/kg

Ingot $25/kg

Billet $40/kg

Mill products $50-70/kg

$Ti$ powder $200-400/kg

$TiO_2$ pigment $3.2/kg

Significant potential for reducing titanium processing costs

Titanium powder could replace mill products and enables near net shape production and 3D printing
Titanium product development

- 2010: PIGMENT, HONEYCOMB PRE-FORM, HONEYCOMB PRODUCT, SPONGE SUBSTITUTE, POWDER
- 2011: PIGMENT, BEAD, SPONGE SUBSTITUTE
- 2012: PIGMENT, GRANULE, POWDER
- 2013: DIRECT ORE, POWDER, 3D PRINTED PART
Potential for metal powder direct from Ore

- Metalysis rutile possesses a tensile strength greater than commercially pure grades (ASTM 1 – 4) of titanium, is equivalent to a weldable armour plate for defence applications, and is ca. 80% that of Ti-6Al-4V (ASTM grade 5).

MIL = MIL-DTL-46077G – Department of Defense, Detail Specification, Armor Plate, Titanium Alloy, Weldable
Additive Manufacturing (3D Printing)

- Metalysis can generate spherical powders in the different size ranges that are currently used in additive manufacturing (3D printing), i.e. typically 45 to 150µm.
- In the Metalysis process a relationship exists between the particle size of the feed and ensuing product, therefore this can be tailored to meet specific customer requirements whilst generating a high yield.

![Metalysis 3D Printing Machine](image1)

![Graph](image2)

![Images of 45 to 75, 75 to 106, and 106 to 150 micron powders](image3)
Metalysis powders have been used to 3D print titanium parts
Why Reduce Material Cost?

- Currently, machine cost, which includes depreciation, servicing, and consumables, is the major cost in metal additive manufacturing closely followed by material cost.

- As machine costs are reduced over time, materials will become the new major contributor if costs remain as they are, typically $200-400/kg for Ti.
Summary
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- Metalysis has developed a unique technology originally based on the FFC® Process, which will be exploited for tantalum production during Phase 1 and titanium powder production in Phase 2.

- Metalysis has an extensive patent portfolio of 25 patent families that is continually being expanded.

- Metalysis has recently completed an investment round with Iluka Resources, who are one of the largest titanium feedstock producers in the world.

- Metalysis have demonstrated spherical Ti powders for additive manufacturing applications and are able to tailor the PSD and chemical composition depending on the end users requirements.

- Potential to recycle titanium powders that have been used in additive manufacturing.

- Our vision is to create new low-cost titanium alloy powders that can expand the market beyond aerospace, biomedical and specialist chemical engineering uses.