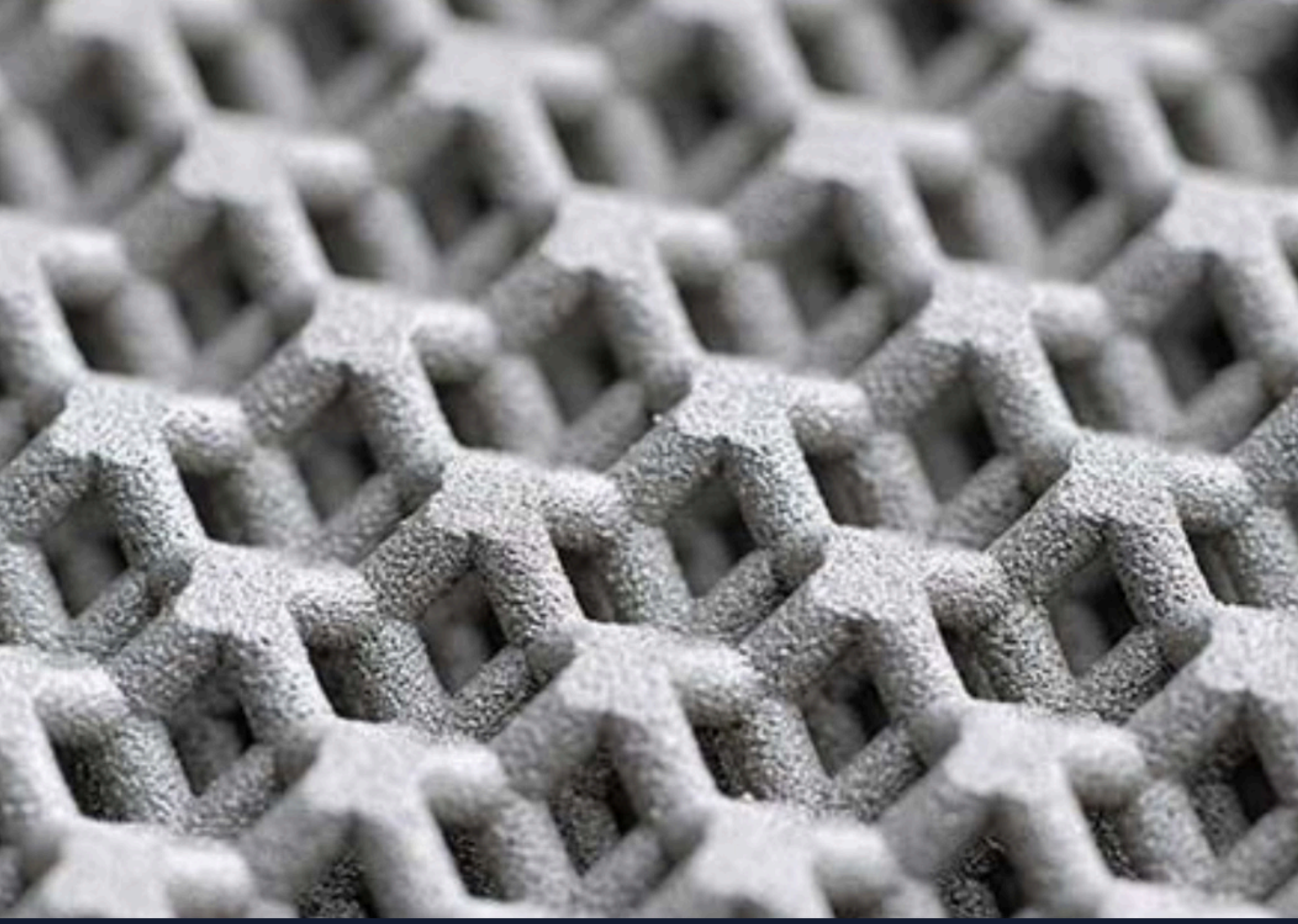

Structural Integrity of Additive Manufactured Materials

JOINT INDUSTRY PROJECT OUTLINE

PROP312611

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Summary

Additive manufacturing processes

Additive manufacturing (AM) is an emerging technology that has gained large interest in the past decade due to its potential to produce customised components with complex geometries. However, before using the AM materials in safety-critical applications, it is necessary to understand the material's behaviour under complex loading such as fatigue. This project aims to perform structural integrity assessment of materials produced via AM focusing on the fracture and fatigue performance of additive manufactured steel, copper, nickel and titanium alloys.

There are various types of AM technologies on the market that can be categorised based on their feedstock and energy source. The focus of this project will be on three AM processes: direct energy deposition (DED), wire-arc direct energy deposition (DED), and laser powder bed fusion (L-PBF).

Structural integrity assessment will be carried out in terms of fracture toughness, fatigue endurance and fatigue crack growth testing in air, hydrogen, and elevated temperature environments, along with post-test analysis and correlation between process-microstructure-properties leading to certification and qualification of the material.

Approach

The AM processes that are focused in this project are direct energy deposition (DED), wire-arc DED, and laser powder bed fusion (L-PBF). Test specimens will be manufactured from each process. In consideration of the layer-wise manufacturing process, and therefore, the anisotropic properties of AM materials, both vertical and horizontal configured specimens will be manufactured. The materials of interest are steel, copper, nickel and titanium alloys.

For each type of material produced by each of the AM processes, fracture toughness, fatigue endurance and fatigue crack growth rate testing will be carried out in air, hydrogen, and at elevated temperature. Post-test analysis, fractography and microstructure analysis will also be carried out to conduct a holistic structural integrity assessment of the materials.

Project Concept

AM is an emerging technology that has gained large interest in the past decade due to its potential to produce customised components with complex geometries. In spite of this great advantage, the material behaviour produced by AM is not fully understood yet, mainly due to the different manufacturing process that the material is going through compared to conventional processes, such as complex thermal history, layer-wise manufacturing, and a large number of process parameters involved in AM; changing each of which can affect the final products in terms of their microstructure and accordingly mechanical performance.

Therefore, it is essential to understand the AM material behaviour before using them in safety-critical applications. It has been observed that many failures in safety-critical components occur due to fatigue and/or fracture. Therefore, it is important to assess the AM material performance under both these modes of failure.

Deliverables

- On completion of each testing scope for each material, the test results will be shared with the project partners.
- Progress reports will be prepared and issued ahead of progress meetings.
- On completion of the testing programme for each material, a final report will be issued detailing the tests performed, the results obtained, the analysis and conclusions drawn.

Price and Duration

The above approach is based on a total budget of £1,000,000 (excluding VAT) over two years (£500k per annum), which requires £62,500 per company per annum from 8 sponsors. The scope of work and associated budget requirements will be finalised following the project launch. A reduced scope of work could be undertaken looking only at two materials for a cost of £500k.

Further Information

For further information on how a Joint Industry Project (JIP) runs please **visit our JIP section** or scan the QR code.

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