THE UNIVERSITY OF SHEFFIELD: A CENTRE OF EXCELLENCE FOR SOLID STATE PROCESSING

Your guide to the facilities available within The University of Sheffield.

The framework enables both business and research organisations to progress from initial concept to pilot stage demonstrator, using combined assets and technical experience.

The University of Sheffield brings together a unique collection of resources for the development and application of Hot Isostatic Pressing, and all within a Centre of Excellence for Solid State Processing.

Royce at the University of Sheffield

Model: AIP8-45H & AIP3-12-60C
W: sheffield.ac.uk/royce-institute
A: Royce Translational Centre, Sheffield Business Park, Europa Ave, Tinsley, Sheffield, S9 1ZA / Royce Discovery Centre, 5 Portobello Street, Sheffield, S1 4ND

Nuclear AMRC

Model: Quintus QIH-62
W: namrc.co.uk
A: Nuclear AMRC, Advanced Manufacturing Park, Brunel Way, Catcliffe, Rotherham, S60 5WG

Department of Materials Science & Engineering

Model: AIP6-30H
A: Quarrell Laboratory, Sir Robert Hadfield Building, Mappin Street, Sheffield, S1 3JD

CAPABILITIES AT THE UNIVERSITY OF SHEFFIELD

Hot Isostatic Pressing [HIP'ing], involves the controlled application of hot, inert gas at high pressure, which creates a unique processing state. Through this, powder, or other solid parts, can be shaped, densified, and/or bonded together, to produce components that would be extremely difficult to manufacture by more conventional processing routes.

Alongside the HIP'ing capabilities of The University of Sheffield, equipment is also available for Cold Isostatic Pressing [CIP'ing]; the encapsulation of powders; and a thermo mechanical simulation laboratory for the optimisation of processing parameters.

With a pilot scale powder manufacturing plant; powder densification through FAST [Field Assisted Sintering Technology]; and a downstream finishing plant, The University of Sheffield can provide access to all resources within the framework of a Centre of Excellence for Solid State Processing.

A BROAD PROCESSING SCOPE

Developed initially for the cladding of nuclear fuel elements in the early 1950's, Hot Isostatic Pressing has since been applied to a diverse range of metallic alloy and CerMet parts. This includes the improvement of Tungsten Carbide Hard metals, the volume production of High Speed and Tool Steel billets, the processing of Beryllium powder mirrors, and Titanium alloy shaped parts.

The use of HIP'ing to provide property improvement in castings significantly enlarged the scope for HIP processing. With a simultaneous increase in HIP plant size, this broadened the scope for both improved process economics, as well as the use of the process for large, high integrity powder parts for oil, gas, aerospace, and power generation markets.

Ceramics, glasses, and composites, all appear to benefit from HIP'ing treatments, as well as a recent and growing interest in the use of HIP for the improvement of Additive Layer Manufactured parts.

UNIQUE RESOURCES & EXPERIENCE

With the range of Hot Isostatic Pressing equipment available at The University of Sheffield there is an ideal mix of resources for initial test piece trials, followed by the option to extend the processing technique to demonstrator sized parts.

Details of the key specifications for the three HIP systems are listed in the Table opposite.

Most importantly, the AIP-6 HIP unit has the additional flexibility to process radioactive materials, such as Uranium and Thorium, using a purpose designed and unique Active Furnace Isolation Chamber. The table of equipment also highlights the key details of the Cold Isostatic Press available at the Royce Discovery Centre, and facilities are available for both the degassing and encapsulation of powders.

Hot Isostatic Pressing & Material Sustainability

Drawing together the benefits of improved properties from HIP treatment together with metallurgical bonding of dissimilar materials, Hot Isostatic Pressing has seen a growing interest in the production of parts with clad surfaces for wear and corrosion improvement.

Recognising both the capability for solid state surface design, together with the control and repeatability of the HIP treatment, components for extrusion, tooling, fluid flow control, and other aggressive environments have benefitted through the consolidation of highly alloyed powders onto the surfaces of complex shapes.

The HIP technique has been applied for the restoration of creep properties in used gas turbine parts, and is under development for the resizing and reuse of worn wear parts.

HOT ISOSTATIC PRESSING [HIP]

	AIP6-30H	AIP8-45H	Quintus QIH-62
HOT WORKING ZONE	80mm diameter x 125mm length	75mm diameter x 300mm length	450mm diameter x 1300mm length
MAX SAMPLE SIZE	70mm diameter x 120mm length (Mo & Graphite)	60mm diameter x 300mm length	405mm diameter x 1240mm length
WORKING PRESSURE	200MPa	310MPa	200MPa
MAX TEMPERATURE	1350°C (Mo)/2100°C (Graphite)	2000°C	1450°C
HEATING RATE	Up to 20°C/min	Up to 25°C/min	Typically 5°C-15°C/min
COOLING RATE	Up to 20°C/min	Up to 40°C/min	Up to 100°C/min
MAX WORKPIECE LOAD	9kg	15kg	1 tonne
ENVIRONMENT	Argon	Argon	Argon

COLD ISOSTATIC PRESSING [CIP]

A: Royce Discovery Centre, Harry Brearley Building, 5 Portobello Street, Sheffield, S1 4ND

	AIP3-12-60C
VESSEL SIZE	75mm diameter x 300mm length
MAX PRESSURE	410MPa
PRESSING TYPE	Wet Bag

ADVANCED THERMO MECHANICAL FACILITIES

With extensive knowlege of, and specific test equipment for, the evaluation of the high temperature behaviour of materials, The University of Sheffield is well equipped to isolate those combinations of pressure and temperature to optimise HIP processing.

Powder consolidation by HIP'ing or FAST techniques can equally be followed up with access to a range of primary shaping equipment to produce shaped sections for further application and property testing.

CASE STUDIES

RADIOLOGICAL HIP'ING: MANAGEMENT OF THE UK PLUTONIUM INVENTORY

Model: AIP6-30H
A: Quarrell Laboratory, Sir Robert Hadfield Building, Mappin Street, Sheffield, S1 3JD

SCAN TO FIND OUT MORE

INVESTIGATING THE BEHAVIOUR OF TI-FE BINARY ALLOYS PRODUCED FROM ELEMENTAL POWDERS DURING THE HIP'ING PROCESS

Model: AIP8-45H
A: Royce Translational Centre, Sheffield Business Park, Europa Ave, Tinsley, Sheffield, S9 1ZA

SCAN TO FIND OUT MORE

BUILDING CONFIDENCE IN POWDER METALLURGY

Model: QUINTUS QIH-62
A: Nuclear AMRC, Advanced Manufacturing Park, Brunel Way, Catcliffe, Rotherham, S60 5WG

SCAN TO FIND OUT MORE

CURRENT RESEARCH & DEVELOPMENT ACTIVITY

1) Analysis of material properties of HIP'ed parts compared to wrought or cast equivalents

2) Consolidation of novel structures such as dissimilar metal joints

3) Procedures to maximise material or component yield

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4) Generation of data to support code cases for adopting powder metallurgy for the civil nuclear sector

5) Binary alloys produced from elemental powders through HIP

6) Bonding dissimilar alloy powders

7) Powder shaping to final size

ROYCE AT THE UNIVERSITY OF SHEFFIELD

8) Consolidation of CerMet powders

9) Consolidation of tailored ceramic, glass, and glass ceramic materials to support the management of nuclear waste

10) Fabrication of simulant nuclear fuel to enable in-depth studies for new fuels, spent fuel, and accident tolerance

QUARRELL LAB, SIR ROBERT HADFIELD BUILDING, THE UNIVERSITY OF SHEFFIELD

Discover more about how The University of Sheffield facilities can support your business.

Please direct all enquiries to our team at royce@sheffield.ac.uk

www.sheffield.ac.uk/royce-institute