PhD Opportunity: Turning Aluminium Waste into High-Performance Parts Via a New Green 3D Printing Technology

Additive Friction Stir Deposition (AFSD) is a new high-throughput, solid-state "3D printing" process that builds metal parts without melting. In AFSD, a feedstock bar is rotated, generating heat through friction so the material plastically deforms; a translation motion then deposits it layer-by-layer while remaining in the solid state. This makes AFSD a powerful route for low-energy, low-emission manufacturing and opens new pathways for circular aluminium production.

Aluminium is crucial to modern society, with a range of applications from packaging to construction, automotive and aerospace. It is also key to the energy transition because its low weight reduces emissions, particularly in transport. Yet producing primary aluminium is extremely energy-intensive. Recycling aluminium via solid-state routes such as AFSD can reduce energy consumption by over 95%, making aluminium recycling one of the most important challenges for reducing CO_2 emissions in the sector.

A significant fraction of aluminium waste comes as chips/swarf/flakes from machining. These are difficult to recycle because each chip is covered by a native oxide layer, and their high surface area amplifies the impact of oxides and contaminants.

This PhD will tackle a major sustainability challenge: transforming aluminium waste (chips/flakes) into high-performance bulk components via 3D printing. Conventional recycling relies on remelting, which is energy-intensive and can degrade properties as impurities accumulate. AFSD can drastically reduce energy use, but it also introduces new scientific and engineering challenges that this project will address, especially the role of oxide layers and oxide networks in bonding, defect formation and mechanical performance.

The project will develop and optimise a solid-state recycling-to-manufacturing pathway, combining recycled feedstock preparation (compaction/extrusion) with high-rate AFSD deposition to produce dense, robust parts. A key objective is to understand how the high strain, intense shear and elevated temperature of AFSD can break up and redistribute oxide layers (and other harmful features), so they are no longer detrimental to the properties of the recycled material. The research will quantify how processing conditions control bond quality, defects, microstructure evolution and final performance.

A core part of the PhD is advanced microstructure characterisation across three complementary laboratories: Deakin University (Australia) for high-throughput AFSD processing, advanced characterisation and mechanical testing, GPM, University of Rouen Normandy (France) for state-of-the-art microscopy and atom-scale analysis and, Chimie ParisTech (France) for expertise in solid-state recycling of aluminium chips (compaction/extrusion). This international co-supervision provides a unique opportunity to work in three leading research environments while contributing to next-generation low-carbon aluminium manufacturing.

Characterisation will include SEM/EBSD (grain structure and defects), and advanced nanoscale tools such as Atom Probe Tomography (APT) and high-resolution Transmission Electron Microscopy (TEM) to understand oxide/intermetallic distributions and their role on performance.

GET IN TOUCH

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IFM INSTITUTE FOR FRONTIER MATERIALS
DEAKIN UNIVERSITY
GPM Groupe de Physique des Matériaux
circAlloy
ARC TRAINING CENTRE FOR RESOURCE EFFICIENT ALLOYS IN A CIRCULAR ECONOMY

Join a Unique International PhD Environment

This PhD offers a unique opportunity to work across three leading research environments: Deakin University in Australia, GPM, University of Rouen Normandy and IRCP, Chimie ParisTech in France. The successful candidate will be primarily be based at Deakin University, where the AFSD facility is located, while also spending time at the French partners' institutions.

Deakin University / IFM / circAlloy (Australia)

The project is part of the ARC Training Centre for Resource Efficient Alloys in a Circular Economy (circAlloy), a nationally funded initiative in sustainable alloy innovation. The candidate will join a cohort of 10+ PhD students spanning alloy design, modelling, advanced characterisation, and circular manufacturing. At Deakin, the student will be based at the Institute for Frontier Materials, a collaborative and multicultural research centre at Waurn Ponds Campus (Geelong)—with excellent facilities and a great lifestyle at the gateway to the Great Ocean Road.

GPM – University of Rouen Normandy (France)

GPM provides state-of-the-art TEM/SEM and APT/SAT, supported by advanced preparation capabilities (e.g. plasma FIB) and unique tools such as SATMET. These facilities enable complementary, multi-scale analysis of microstructure, defects, and chemistry to reveal mechanisms operating during high-rate solid-state processing.

IRCP – Chimie ParisTech (France)

IRCP brings leading expertise in solid-state recycling of aluminium chips, including compaction and extrusion to prepare recycled feedstocks. This strengthens the project's circularity focus and supports a complete recycling-to-manufacturing pathway.

Why complete this PhD?

- Undertake a truly international PhD experience across three universities and three laboratories
- Work in a project combining metal 3D printing, alloy design, advanced characterisation, and sustainability
- Benefit from access to complementary facilities and expertise in Australia and France

Who should apply?

We welcome applications from motivated candidates in Materials Science, Mechanical Engineering, Metallurgy, Physics, or related disciplines, particularly those interested in additive manufacturing, microstructure–property relationships, advanced characterisation, and sustainable materials.

What's on offer?

- Deakin University PhD scholarship: AUD $40,581 per annum (tax-free) for 3 years
- International candidates: full tuition fee waiver for up to 4 years
- Opportunities for research training, international collaboration, and industry engagement

Applicants must meet the entry requirements for a PhD at Deakin University. Visit Deakin university's HDR webpage for more details.

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