



NICER PROGRAMME & INNOVATE UK CIRCULAR ECONOMY FOR SMEs

Circular Niobium



Exploring the opportunity to develop a value chain for niobium recycling

Beta Technology with project partners Echion Technologies Limited, British Geological Survey and Met4Tech

The Challenge: What we were trying to achieve

This feasibility study assessed the economic, technical and environmental opportunity to develop a value chain for the recycling of niobium products. This project aligns with theme 1 (Virtual data Observatory), and theme 3 (Design, Manufacturing and Recycling Technologies) for the Circular Economy Centre for Technology Metals (Met4Tech).

Niobium is a transition metal, used in varying amounts in a wide variety of materials, including steels and superalloys. In steels, only a very small amount (~0.1%) is used to greatly improve performance. More recently, niobium is being used in new applications, including new anode and cathode materials in batteries. Although the volume of niobium consumed by these products is relatively small, its impact is high through substantially improving the performance of steels and batteries. Globally only about 0.3% of niobium is currently recycled back to a niobium product, mainly from high content niobium products such as superconducting electromagnets.

The project had three areas to consider:

- the understanding of the niobium product flows into and out of the UK and Europe;
- the development of a cost model for recycling niobium from battery materials;
- the exploration of business models that could support a market in secondary niobium products to provide an alternative material source.

The Approach: How we tackled the challenge

The project was designed around the strengths of the partners to examine three key areas:

- Material flows
- Cost model for recycling battery materials containing niobium

- Developing business models and engaging the value chain

To support the collection of data it was important to the project to have access to the world's largest supplier of niobium products. This enabled a more accurate picture of material flows to be developed and to check against trade data.

The project has developed an initial understanding of the material flows and has highlighted where additional data is required.

The detailed cost model for recycling niobium from battery materials shows there is potential for the recycling to be economically viable, alongside other battery materials.

Current opportunities for recovery and recycling niobium are mainly in superconducting electromagnet applications, found for example in MRI scanners. In the future however and assuming that the market for batteries containing niobium increases considerably, the opportunity for recovering niobium from spent batteries is significant.

Stakeholders along the value chain have been engaged and an outline business model is being developed. Earlier engagement with stakeholders in the value chain would have helped in developing the business model.

Unexpected outcomes: What we learned along the way

The project did not have any unexpected outcomes. The project did confirm that issues around data collection and its availability makes it difficult to gain a true picture of material flows.

One of the outcomes was a greater understanding of the MRI scanner market and that most scanners become re-used perhaps several times during the life of the core electromagnet. This means that the volume of end-of-life MRIs is not as high as originally expected.

Key Learning: What We Would Do Differently Next Time

The project ran according to plan, but earlier engagement of the value chain may have assisted in developing the business model further within the project's lifespan.

The project was originally focused on looking at the flow of niobium material into and out of the UK. It soon became clear that UK data has been, until Brexit, very intertwined in European statistics, and today it is difficult to separate the two due to how the trade data is collected. Starting from day one with a focus on the UK and Europe would have been better.

The Outcome: What We Achieved and How It Has Impacted the Business, Society and Key Stakeholders

The project developed a deeper understanding of the niobium material flows in the UK and Europe. This understanding is incomplete as some data is missing/ not collected or may be inaccurate, and this has led to inaccuracies in the flow model developed. However, the model has shown areas to focus on for potential sources of waste material for recycling such as MRI scanner production waste and end of life machines.

The material flow analysis will support the Met4Tech development of the National Virtual Data Observatory.

The cost model for the recycling of battery material containing niobium was developed to a greater depth and will allow future modeling for the partner directly involved in the project. The model, with modifications, may be appropriate to use in other product applications.

The development of the Circular Niobium Knowledge and Innovation Centre as a legacy of the project will enable the development of value chain activities supporting the use and recycling of niobium. Its aim will be to connect current users and potential new users with the opportunities to use niobium in many applications, and then with the recycling value chain to develop their understanding supporting the formation of a circular economy for niobium.

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Research was carried out by Beta Technology with support from the Circular Economy Centre for Technology Metals and project partners Echion Technologies and British Geological Survey.

For the lead partner, Beta Technology, this provides a new knowledge-based service through the Circular Niobium Knowledge and Innovation Centre.

For Echion Technologies this provides the opportunity to demonstrate the opportunity to recycle niobium in their application and therefore supports the need for recycled content in their product.

For British Geological Survey the project has added to their knowledge base that will support other users through public access to material flow analysis data.

Looking Forward: Next Steps and Future Directions

There are a number of next steps that have been outlined within the project's exploitation roadmap. These include:

- Development of the chemical reprocessing system
- Understanding the environmental impact of the recycling process vs access to primary material
- Development of the whole waste collection and processing activities
- Value chain development
- Market engagement

Initial focus will be on:

- Further work on the material flow analysis
- Bench level development of the reprocessing of niobium
- Engagement with key stakeholders in the value chain

The Circular Niobium Knowledge and Innovation Centre has an initial landing page on the Beta Technology website: <https://www.betatechnology.co.uk/circular-niobium>

A LinkedIn group has been formed to facilitate engagement with stakeholders and to test out ideas. <https://www.linkedin.com/groups/12790382/>

