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Special Edition
RECYCLING

ON THE ROAD TO RECYCLING

**HOW CAR RECYCLING IS DRIVING
SUSTAINABILITY FORWARD**



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Amy Fanagan has found
her passion

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RESEARCHING BETTER SOLUTIONS

FOR ALUMINIUM RECYCLING



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The AIT Austrian Institute of Technology is spearheading the EU project RecAL, which focuses on promoting sustainability, resource efficiency and a circular economy within the aluminium industry.

By Helena Nageler-Petriz

A new initiative recently launched in Vienna, Austria, the RecAL (Recycling Technologies for Circular Aluminium) project, seeks to advance cutting-edge recycling technologies and develop a digital platform to support a circular aluminium economy. Funded by Horizon Europe, the project unites 19 partner organisations from nine European countries and is coordinated by LKR Leichtmetallkompetenzzentrum Ranshofen, a subsidiary of AIT Austrian Institute of Technology. The project aims to revolutionise aluminium production and reuse through the creation of a digital cockpit, the RecAL Hub, which will facilitate the circular economy for aluminium recyclates across Europe, connecting suppliers, buyers and technology providers. WMW talked with Clemens Simson, Senior Research Engineer at AIT, about the project.

How did the RecAL project come about and what key challenges led to its creation?

Clemens Simson: The challenges of recycling aluminium and a stable European resource supply are “daily drivers” for all partners of the consortium. There are established cooperations between the industrial partners and research institutions. Moreover, the RTOs regularly engage in dialog on challenges and project opportunities via associations like EARPA. Therefore, the call in the Horizon Europe work programme provided a perfect fit to concert these efforts and take them to a larger stage.

Most importantly, the dimension of the project enables integration of technological solutions for particular problems into a larger, digitally enhanced framework that can bring these solutions to work as a whole.

Can you give us an overview of the main objectives of RecAL and what concrete results you expect from it?

The main objectives of RecAL are twofold. First, technological challenges and solution concepts were identified that would

create a large and sustainable impact in the field of aluminium recycling, ranging from impurity-tolerant alloy compositions for high-volume applications to advanced digital concepts for traceability of value streams. For example, at least 5 new alloy designs will be developed for applications ranging from electrical wires for e-mobility to large-volume structural alloys for both the automotive and construction sector.

Second, the so-called RecAL Circularity Hub will be developed as a platform that can bring together all stakeholders in the aluminium recycling market, similar to modern vendor platforms. The basis for this will be a unified language – a robust ontology for recycled aluminium.

How does RecAL position itself in the context of the European Green Deal and what contribution does it make to decarbonisation?

Aluminium and its alloys are vital to achieve sustainable transportation and construction. RecAL is therefore designed to act as an enabler in that industry. First, bringing together stakeholders across the value chain will facilitate maximised utilisation of recycled materials. Second, faster integration of technological advances across the value chain through increased cooperation and transparency, be it in materials, processes or logistics, will make it possible to manufacture products that either match or exceed the performance of those made from primary materials today.

What is the challenge in recycling aluminium?

The main challenge in recycling aluminium is that traditional alloying systems are usually based on only one, or a maximum of two main alloying elements to establish the desired properties. When molten together arbitrarily, they often form unwanted intermetallic phases that can only be reversed by diluting with fresh primary material, thereby partly negating the positive effect of using recycled material.

When looking at EoL products, these alloys can hardly be distinguished with state-of-the-art methods, hence pristine sorting becomes too cost-intensive in most cases. The challenge at large is hence to find



The semi-industrial direct chill casting machine for horizontal continuous casting of aluminium alloys with real time control unit at the AIT.

solutions that on the one hand increase sorting quality and efficiency, and on the other hand create alloys that are more tolerant against impurities by at least one order of magnitude.

How high do you see the recycling potential of aluminium?

The recycling potential of aluminium is close to 100% when only considering the material. It is the value chains that must be connected more effectively, in combination with faster uptake of technological solutions for sorting, dismantling, refining and improved alloy design.

According to studies, the resourcing potential of secondary aluminium would still lie in the range of 50% in 2050. This can be realised if concerted, transparent efforts are taken in the aluminium industry, both horizontally and vertically.

Which of the technological solutions for aluminium recycling that are being investigated as part of RecAL do you consider to be particularly pioneering and why?

All 14 "Circularity Amplification Technologies" (CATs) of RecAL tackle relevant problems in an innovative way. If we had to pick one, it has to be the Circularity Hub, as it is envisioned to be an enabler both for traceable and efficient value chains in Europe and faster uptake of sustainable technologies, be it new alloys or e.g. sorting/cleaning technologies.

How are digitalisation and robotics being used in RecAL to improve the recycling of aluminium?

Digitalisation is a cornerstone of most tasks performed in the project. Obviously, the Circularity Hub will be the digital equivalent of the real value chains. Beyond that, blockchain technologies will be developed to enable traceability over multiple life cycles of materials. AI-assisted exploration of multi-dimensional phase fields will be showcased to "unlock" new generations of recycling alloys.

Robotics is vital to realise advances in the sorting of scrap towards the precise separation of even specific alloys and the dismantling of complex structures from

e.g. aeronautics. A use case of the project will be to dismantle airplane sections into single parts from separated alloys.

How is technology readiness level 6 (TRL6) achieved and what does this mean in concrete terms for industrial applications?

TRL6 will be reached, or better, showcased by executing at least 3 use cases by the end of the project. "Use case" means that a technological solution, e.g. a novel alloy design, will be manufactured at semi- or full industrial scale facilities of individual project partners, using real End-of-Life precursor material that has been sorted and cleaned via the respective methods developed in the project.

This value chain example will be traced and evaluated automatically with regard to its life cycle impact with tools integrated into the Circularity Hub.



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"THE RECYCLING POTENTIAL OF ALUMINIUM IS CLOSE TO 100%."

Clemens Simson,
Senior Research
Engineer at AIT



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Aluminium production at the AIT.



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What is the RecAL Hub and what role does it play in connecting suppliers, buyers and technology solution providers?

The RecAL Circularity Hub (HUB) can be seen as a “digital cockpit” to collect data on the materials from the relevant suppliers, buyers and service providers and to match-make, anonymise, provide dashboards & analyses for the recyclers & other industrial partners.

How will the digital platform help to promote the circular economy of aluminium in Europe?

With the information provided by the Hub, production companies (parts manufacturers – OEMs, TIER) can better adjust their production lines and, if implemented successfully, this will lead to an increase in product quality and reductions in production costs and, in turn, environmental costs. By the end of the project, the Hub should allow project partners (and selected stakeholders as test users) to track/simulate aluminium recycle in volumes, weights, qualities and other characteristics which are defined as needed by various actors in the value chain.

What challenges do you see in the introduction and use of this platform and how will these be addressed?

The main challenge of the Circularity Hub is to find a common language for all stakeholders across the secondary aluminium value chains and, later, beyond. Furthermore, we are working in an industry

Aluminium is extracted from bauxite, which is primarily mined in (sub-) tropical areas.

that often does not act very transparently. We see a certain hesitance to adopt novel approaches or open supply chains that were established maybe decades ago. Also, the Hub must prove it is capable of balancing increased efforts of pan-European logistics with the benefits of tailored material streams. The project itself will showcase that in several use-case scenarios, but we will pay significant diligence to displaying the universal methodological robustness of the approach.

RecAL brings together 19 partner organisations from nine European countries. How do you coordinate the cooperation and what role does communication between research and industry play?

The overall project is structured in a cascaded way. Large topic areas, the “clusters”, are led by respective cluster leaders from partner organisations, which coordinate the individual tasks that ultimately lead to the development of the aforementioned CATs.

The communication structure is designed to allow for intense intra-cluster communication, but also ensuring that all partners are informed and involved in the overall project progress.

Almost all tasks are executed by teams that involve colleagues from research and industry partners. The executive board of the project is also intentionally balanced between the two categories.

How does the LKR Leichtmetallkompetenzzentrum Ranshofen contribute its expertise as project manager and what specific tasks does it take on in the project?

LKR has been coordinating projects since its origin in 1994 and hence has vast experience in handling large-scale projects. The project manager is closely integrated into the specific technological team, thereby making sure that project management requirements and technology development goals are aligned.

Beyond coordination, the main technological tasks of LKR are focused on alloy development, which comes naturally given its status as a “light metals competence centre”. The casting alloys for large structures, for



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example, are based on LKR's own advanced alloying methods, so-called "nanoeutectics".

How does RecAL contribute to the reduction of primary aluminium in the long term and what are the benefits for the environment?

We identified 14 so-called "Circularity Amplification Technologies", that will be developed towards a technology readiness level of up to 6, which is the boundary to industrial implementation. Each of them contributes to an increase of secondary resource use in respective applications of up to 70% individually and up to 85% in total.

As the use of secondary aluminium consumes only 5% of what pristine material requires, this is a major impact potential towards fulfilling the Commission's goals for net-zero emissions in the future.

What role does the development of recycling-tolerant alloys play in the overall project and how are these being tested in an industrial environment?

The development of recycling-tolerant alloys is a cornerstone of the project. The alloys that are developed in the project will serve as viable solutions for different applications themselves and incorporate novel alloy design approaches that were not available when the materials that are in use today were developed.

Moreover, by combining them with faster methods for advanced characterisation, which is necessary for an actual uptake by suppliers and OEMs, the alloys of RecAL serve as a showcase to other material solution providers. The alloys are tested either directly by the industry partners using their respective production facilities or at research partners' facilities that can simulate a TRL6 equivalent environment. For example, the High Pressure Die Casting facility of LKR is equipped with toolings that can validate the material behaviour up to the regime of so-called gigacasting.

Is there already a shift towards recycling-tolerant alloys?

The steps towards recycling-tolerant alloys we see today are hesitant, to say the least. There are several solutions for particular alloy groups in academia and research, but qualification and uptake by OEMs is, to date, hardly realised. It is still cheaper and easier

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to either use primary material or claim recycling ratios by using pristine production scraps. This is not real recycling from EoL sources, though.

*How does the production of these alloys differ from conventional aluminium alloys?
How do you see the future of the aluminium circular economy in Europe after RecAL is completed?
What further steps are planned?*

One essential boundary condition we defined was that all materials developed must be suitable for existing production routes. One change the project will promote is that you can unlock huge potential in alloy design when you move from the traditional alloy definitions of today (each element is defined in an independent, explicit range) towards connected definitions (elements are defined in relation to each other). This will require advances in procurement and melt metallurgy protocols, but not the methods to manufacture the materials themselves. RecAL is intended to showcase this potential, and also to integrate such alloys into the Circularity Hub as a viable business model for themselves and future alloy designs. Also, the Hub itself is intended to be operated beyond the project, hopefully as THE future platform connecting the whole European aluminium landscape.

How do you assess the potential of RecAL to change the aluminium industry in the long term?

We deem the potential to be immense. While the particular technological solutions in the project do not solve all problems inherent in the industry, they will serve as flagship "sparks" in high-impact applications with respect to circularity and European resource autonomy. By creating a hub that is open to all stakeholders and connects different stages of the value chain – from research to OEM – with a common language, we are convinced that RecAL will serve as the basis for accelerated uptake of sustainable technologies and value chains. —

