

THE CIRCULAR ECONOMY

Putting The Circular Economy Into Practice

Taking innovative ideas
from pitch to product

growthgarage.mcam.com



Growth Garage

INTRODUCTION

Growth Garage is a business accelerator program from Mitsubishi Chemical Advanced Materials. Our mission is to support and grow new ideas using our technologies and advanced engineering materials to help tackle some of today's most significant engineering challenges.

A key aim of our sustainability strategy is creating a circular economy. Sustainability, or KAITEKI, is at the centre of everything we do and the ideas we support. We are inviting engineers, designers, entrepreneurs, innovators, start-ups, businesses and students to submit their ideas, technologies, products and services as part of our Growth Garage Circular Economy (CE) Challenge.

What is KAITEKI?

KAITEKI is the Japanese word for 'well-being'; for Mitsubishi Chemical however, the term has a much broader, more profound meaning which reflects the sustainable well-being of people, society and our planet Earth.

KAITEKI is an original concept of the Mitsubishi Chemical Holdings Corporation Group that proposes a way forward in the sustainable development of society and the planet, and serves as a guide for solving environmental and social issues.

KAITEKI can contribute to making people's lives better by adopting three key terms – 'Sustainability', 'Health', and 'Well-being' – and by saving our resources and protecting our environment. We strive to align the whole company, its operations and products to these values. They guide our business decision making and drive our commitment to invest in the research and development of technology and strategies around the circular economy.

Sustainability means meeting our own needs without compromising the ability of future generations to meet theirs. More than ever before, we believe that achieving excellence demands planning with the future in mind – while taking decisive action in the present.

“We must transform every element of our take-make-waste system – how we manage resources, make and use products, and what we do with the materials afterwards. Only then can we create a thriving circular economy that can benefit everyone within the limits of our planet.”

<https://ellenmacarthurfoundation.org/>

KAITEKI Vision 2030

Build a sustainability management system



Measurement of financial, social and environmental impact along the life cycle



Reduce environmental impact



Promote a circular economy



Feasibility studies of KAITEKI factories



Henning Bloech

Global Director
Sustainable Solutions,
Mitsubishi Chemical
Advanced Materials

To find out how Mitsubishi Chemical is putting KAITEKI into practice, we first spoke to Henning Bloech, the Global Director of Sustainable Solutions at Mitsubishi Chemical Advanced Materials (MCAM). We started by asking him about the partnerships they're making to enable the circular economy.

So far, we've made several investments in

recycling technology and infrastructure. For example, we're expanding MCAM's capabilities to mechanically recycle engineering polymers that we're using in our products, even though some are complex and require very demanding applications to recover them. Recent investments include a specialized polymer recycling facility in Switzerland and CarboNXT, a company in Northern Germany, to recycle carbon fibre composite parts. Both are at the forefront of the circular economy.

How are you working across the supply chain to take back waste and end-of-life materials to recycle them and put them back into the system?

We partner with customers and our suppliers to collect and recycle MCAM's products and materials. MCAM is situated in the centre of the value chain, which puts us in a unique position. We have many different partners along the chain. Some are creating polymer feedstocks or selling stock shapes, which then go to the next tier of businesses that might use a CNC machine to turn them into parts. They, in turn, might sell them to an OEM (original equipment manufacturer) which makes the final product, and that might turn up in anything from a wind turbine to a plane or car to a manufacturing application.

We partner with suppliers to figure out how to help every part of the chain become more sustainable and circular. This may include more partnerships with external providers that specialize in reverse logistics, sorting and collecting materials, and potentially even processing some of those end-of-life materials.

Is there anyone else in the chemicals industry doing this?

Many companies are doing similar things in other sectors. For example, there are industry initiatives in the plastics industry, the building industry, and the apparel industry. I believe we're at the forefront of this within our industry, but I can see everyone moving in that direction. There is a lot of activity going on, and I expect to see industrywide initiatives as well as some across industries. We clearly see the need to take responsibility for our raw materials downstream, taking them back and recycling them as much as possible. And ultimately, we can only do this collaboratively. So if MCAM takes back a material, maybe even one we don't make, we have to find an outlet for it with businesses that can produce high-value products. So there need to be partnerships across the whole industry and the ecosystem we support.

What does KAITEKI mean to you?

I wasn't aware of the term KAITEKI before starting my position with Mitsubishi Chemical Advanced Materials. However, the concepts and management philosophy that KAITEKI represents are pretty familiar and reflect established sustainability principles. It allows us to tell our story a little differently but, ultimately, it is about balancing environmental, societal and economic sustainability. We are continually embedding those ideas into our business – with our business leaders, engineers, sales engineers and everyone else across the organization.

How are you using KAITEKI to close the loop on sustainability?

We recycle our own and our customers' waste wherever possible to enable a circular economy. We've reduced waste across our sites by utilizing our advanced materials and technologies. Meanwhile, our high-performance, lightweight materials help decrease our customers' manufacturing footprints and improve fuel economy, energy use and longevity in a diverse range of applications, from aviation to robotics.

As part of our commitment to the circular economy, we're collecting much of our manufacturing and processing scrap for immediate reuse. This enables us to reduce waste throughout our manufacturing and processing operations.

“The circular economy is a means to address many key environmental issues and ultimately reduce negative environmental impacts.”

Henning Bloech

And wherever possible, we sort our manufacturing waste and recycle it back into high-value products both internally and externally. We’ve also implemented production processes to collect our customers’ scrap, waste or unused products and recycle these without downcycling.

What are your biggest priorities over the next decade?
First, we aim to reduce our overall energy use while increasing our energy efficiency, therefore reducing greenhouse gas emissions. Globally, 21 out of our 40 sites already get their electricity from renewable sources. In addition, five of these sites also offset their remaining emissions.

We also have three goals that we aim to achieve by 2030...

2023	BECOME CLIMATE NEUTRAL
2025	ZERO PLASTIC WASTE TO LANDFILL 20% REDUCTION IN WASTE AND WATER USAGE
2030	ACHIEVE A CLIMATE POSITIVE STATE

What challenges do your customers face around circularity?
The circular economy is a means to address many key environmental issues and ultimately reduce negative environmental impacts. One approach may be to rethink our current products and designs. How would you design an existing product today based on current knowledge? Would you create it the same way and, if not, how would you design it to meet today’s and tomorrow’s needs? We aim to enable our customers to meet their sustainability needs and achieve their objectives.

Are there some products that really can’t be recycled?
Unfortunately there are, at least based on current technologies and recycling infrastructure. Most challenging are products made with multiple materials which are bonded together. Sometimes some of the materials can be recovered, but rarely all. Take carpet,

for example. We have been trying to recycle carpets for years, but it has proven very difficult and costly. In general, carpet involves many materials; it can be dirty and very complex to recycle back to its base materials at the end of its life. There are some solutions, such as mono-material products or specialized recycling processes, but generally the results have been somewhat disappointing. I believe the whole chemical industry needs to explore how we can redesign products that are currently difficult or impossible to salvage due to their design or the substances they contain. We need to be innovative and ultimately replace them wherever possible with circular products.

What role do the Growth Garage Challenges play in what you and MCAM are trying to do?
They offer an excellent opportunity to tap into a wider knowledge base and “hive mind.” For example, when we look at decarbonization, there are a lot of opportunities to work with start-ups, academics, scale-ups and other businesses across industries to develop and share innovative approaches, solutions and best practices. We are always interested in inputs that make our processes and products more efficient and sustainable.

I’m also excited about the latest Growth Garage CE Challenge, which is centred around the circularity of specific products or materials. For example, it’s easy if you have a single, pure polymer product that we mechanically recycle. In most cases, its performance is very close to a virgin polymer. Many of the advanced engineering polymers we produce or work with can be recycled many times without losing their properties. But we face some issues when, for example, we take back composite materials made up of different materials or polymers with specific fillers or additives. Let’s say we have a polymer with glass fibres, a lubricant additive or carbon fibres to give it specific performance criteria. The polymer chains haven’t changed even though these things have been mixed together, but we still need to figure out how to separate the different elements for recycling. It’s great for us to find smart people and work with them to figure out how to solve these challenges and find sustainable solutions. We’re really looking forward to both learning from and working with the winners.

We’re also exploring different types of chemical recycling technologies for some of the more challenging mixed-waste streams.

In addition we’re looking for new ideas to track and trace materials through the whole supply chain. For

example, how can we get better access to waste and by-products when the end-user is done with them? For many end-of-life products, there’s no coordinated system right now to trace the materials and get them back for recycling so that we can close the loop. This is becoming more important, not only for us but also for our customers. We know that many new businesses are starting up and are thinking through how to develop tracking systems and improve recycling infrastructures.



Tim Vorage
Founder and Manager
of the Growth Garage
at Mitsubishi Chemical
Advanced Materials

Tim Vorage is the Founder and Manager of the Growth Garage at Mitsubishi Chemical Advanced Materials. We started by asking him about the company’s drive towards zero waste.

Our business model moving forward is all about transparency. We are trying to help our customers decrease their carbon footprint and move to zero waste. We are taking back

materials from our customers’ production so they can be recycled, reused and fed back into the loop. The issue is that not all the waste comes from our products, which we can trace, but sometimes comes from other suppliers, complicating the recycling process.

How are you putting the KAITEKI philosophy into action for your customers?
For me, KAITEKI is about future-proofing our customers’ business. Forward-thinking businesses capable of significantly reducing their carbon footprint or tying their business model towards a circular economy will create a competitive advantage. This will ensure they’ll find themselves better positioned to create more value in the next five to 10 years.

We are offering customers the support they need in helping them get there and show that they’re a responsible and sustainable business. We start with providing our customers transparency on their current carbon footprint. This is followed by suggestions to jointly implement solutions to reduce their carbon footprint and minimize landfill by taking back waste from production (or even end-of-life) and feeding it back into the loop.

“Forward-thinking businesses capable of significantly reducing their carbon footprint or tying their business model towards a circular economy will create a competitive advantage.”

Tim Vorage

The issue we face around KAITEKI, or the circular economy, is that not everyone has experienced the benefits it could bring. By running the Growth Garage CE Challenge and creating proof-points with the winners, we can showcase the benefits of adopting a circular business model and, in parallel, build the ecosystem that is required for implementation.

Do you still have a problem recycling some of the things you produce?

We are developing an extensive takeback scheme. We're already working with some of our customers to help close the loop, and then scaling it to help even more customers. Some polymers, polymer mixtures or combinations with metal inserts are more challenging. However, we are committed to finding solutions for all issues that present themselves to our customers and us. For example, we may have a mixture of different polymers; they can also be in different colours, so sorting these for recycling can be challenging. The other issue we face is that if a polymer has gone through the recycling loop a second, third or fourth time, at a certain point those materials can lose some of their properties, often referred to as downcycling. Innovations are required to ensure that the polymers can 'repair' themselves along the recycling process. This explains why we reach out to innovators and entrepreneurs around the globe via our Growth Garage Challenges. They enable us to surface innovative ideas that can help eradicate some of the most significant issues we face today.

Mitsubishi Chemical's commitment to KAITEKI and the circular economy extends across all the different businesses within the group. Dr Lisa Weigand, Advisor

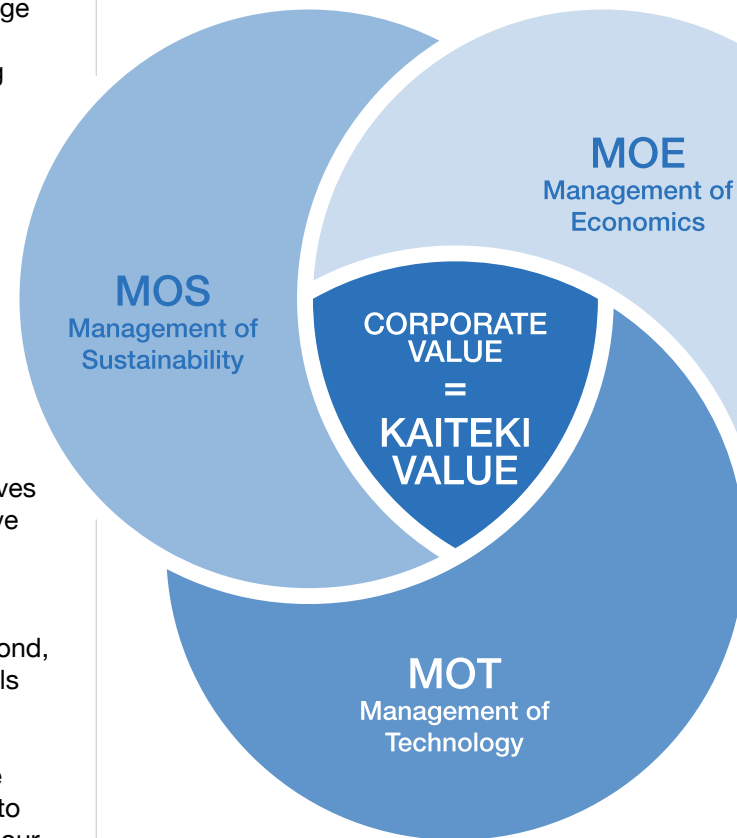


Dr Lisa Weigand

Advisor Circular Economy,
Mitsubishi Chemical
Europe

Circular Economy for Mitsubishi Chemical Europe, works at the regional headquarters in Frankfurt. We began by asking her how the new generation of chemists and chemical engineers, like herself, see sustainability.

When you first think about chemistry, many people don't think about it in terms of sustainability. The public image of the chemical industry is often not very



positive. What is interesting is that the chemical industry produces most of the materials we have around us. In pretty much every part of our lives, we use products made from materials that are produced by the chemical industry, such as plastics, which can be found in computers or food packaging, for example. I believe that the chemical industry can make an enormous contribution to manufacturing greener products by using fewer resources, less energy, innovative recycling technology or renewable resources, and by producing less CO₂.

We also notice that more and more of our b2b customers and their end consumers put a focus on the sustainability of the products they purchase. We observe several trends here: the market asks for products with a low carbon footprint. These products contain recycled or biobased content, products that are safe and sustainable by design or are designed for recyclability. As the manufacturer of those products, the chemical industry has started working on all of those topics. Our company sees this as a priority for our business for decades to come.

Can you tell us a little about your role within Mitsubishi Chemical?

Mitsubishi Chemical Corporation established a Circular Economy Department in Tokyo, Japan, in 2019, which works on the implementation of the circular economy across our company. Its European counterpart was established in 2020 based in our regional HQ in Frankfurt, Germany, where I'm based. We work with all the different group companies that make up Mitsubishi Chemical Europe. We act as in-house consultants and work with our in-house clients on all aspects of sustainability. My work includes many different topics. For example, I advise the group companies on circular economy business models such as 'close-the-loop' or 'product-as-a-service', on how they can make their products more sustainable by using recycled content or biobased raw materials, and on how to reduce their product's carbon footprint and the carbon footprint of their operations. I also follow regulatory trends and advise our clients on new legislation that will be implemented in Europe. I study market trends and follow the development of new technologies. The aim of our Circular Economy Department is to transform our company to be a leader in sustainability and the Circular Economy.

You are working with Growth Garage on this latest Circular Economy Challenge. Why are they so important to the business?

We are working towards implementing our KAITEKI philosophy and the circular economy in our company, but we can't do it alone. One company alone will not successfully transform the current linear business model into a circular one. This is partly because the chemical industry deals with very complex and intertwined supply chains.

Additionally, to make circularity and closed-loop systems work, we must constantly innovate with new technologies or business models. We need to partner with businesses across the value chain – big and small – to drive further change to increased sustainability. How important is collaboration for Mitsubishi? It is a crucial part of our DNA and is helping us ensure the well-being of people, society and our planet Earth - KAITEKI.

“To make circularity and closed-loop systems work, we must constantly innovate with new technologies or business models.”

Dr Lisa Weigand

Recycling Solutions

Recycling plastics conserves natural resources and demonstrably contributes to reducing greenhouse gas emissions that are harmful to the climate. Mitsubishi Chemical recognizes that sustainable development is a critical challenge and that the global business community has an important role to play in the achievement.

Our high-quality recycling products are produced according to highest and uniform quality standards. As material experts with extensive experience, we concentrate on the professional processing of thermoplastic materials and are known for high-performance engineering plastics. Here are some of the techniques we are using today:



RECYCLING

- Documented waste disposal
- Material purchasing
- Supply of containers and replacement containers; baling press available upon request
- Compaunding, pelletizing and material processing in compliance with customer specifications
- Recalling of partial lots
- Development of concepts for the disposal and recycling of your plastic-production wastes



GRINDING

- Labeling and sorting of the delivered material (from 100kg)
- Grinding, disposal of dust and metal residues
- All common thermoplastics (production scrap, sprues, chunks, large-volume molded parts, powders, foils, profiles, filaments)
- Freely selectable grinding range between 6mm and 10mm
- Return delivers in octabins or bin bags



REGRANULATION

- Regranulation of all common thermoplastics (production waste, sprues, moulded parts, regrind, foils, fiber-containing plastics)
- Homogenization to achieve uniform processing parameters (as per your requirements)
- On request compounding with additives according to your requirements
- Regranulates free from dirt particles and foreign matter, easy to process



COMPOUNDING

- Addition of colour pigments
- Colouring of granules according to your colour samples (RAL Pantone, HKS), from 300kg
- Addition of special pigments
- Improvement of technical properties
- Delivery in any desired, common packaging unit



SORTING, PURIFYING

- Pioneering inspection, analysis and sorting system for material purity at highest quality level (X-ray technology)
- Precise granulate inspection for metallic and organic contaminants under clean room conditions
- Intelligent combination of X-ray and optical technology
- 100 percent purity check – outside and inside – to exclude contaminated granulate



TOLL MANUFACTURING

- Toll contract processing of all common thermoplastics
- Regranulation of your thermoplastic waste and residues
- Many years of experience, professional production area, quality management
- ISO 9001: 2015 certified
- 100% inspection of the plastic reggranulate using latest analysis technology

“To meet the challenges of
tomorrow we have to nurture
the visionaries of today.”

Tim Vorage

To learn more about how you can participate in the 2022
MCAM Growth Garage Circular Economic Challenge, go to
growthgarage.mcam.com and download the entry pack.



MITSUBISHI CHEMICAL
ADVANCED MATERIALS

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