

BioCircular Materials Alliance

2024 Progress Report

January 2025



Contents

1. **Introduction**
2. **Formalizing of the Alliance**
3. **Developing the Action plan**
4. **Creating tools for BioCircular product design**
5. **Call to action**
6. **Acknowledgements**

1. Introduction

Biological Materials, created by living organisms such as plants, animals, and microbes, are the building blocks of life on Earth. These remarkable materials sustain ecosystems through natural processes, breaking down into organic matter and regenerating as nutrients—a cycle that has powered life on our planet for billions of years. Now, this same process can help solve some of the biggest environmental challenges we face today.

The urgency to act has never been more clear. Industries worldwide, particularly textiles, are grappling with the consequences of unsustainable linear systems: extract, use, discard. This approach has driven resource depletion, filled landfills, and severely harmed ecosystems. The global textile industry alone generates millions of tons of waste annually, much of which ends up incinerated or in landfills, contributing to environmental degradation.

We stand at a transformative moment. Advances in biotechnology and materials science offer unprecedented opportunities to rethink how we design, manufacture, and manage products.





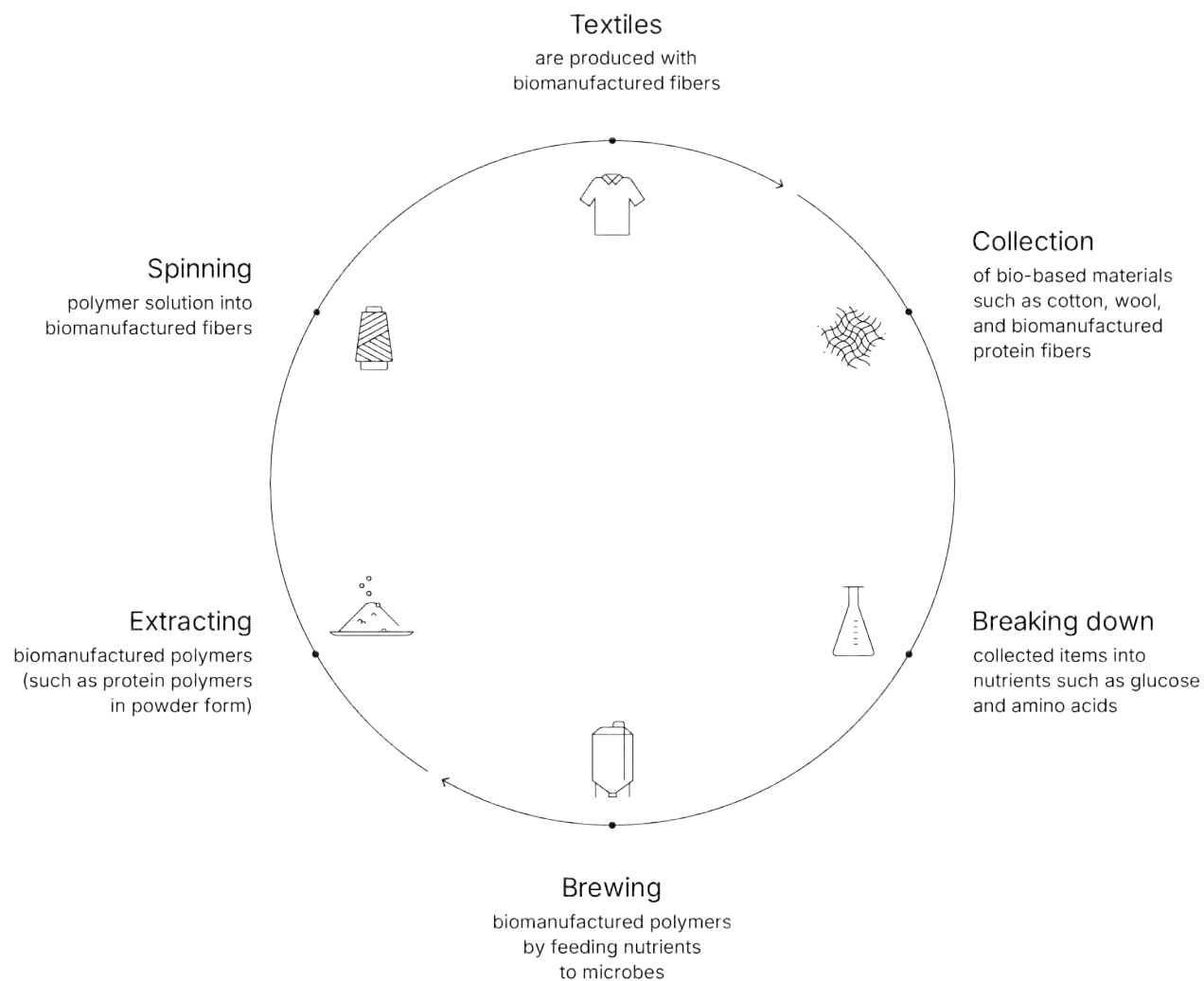
The BioCircular Materials Alliance (the “Alliance”) was created to harness the power of biology to drive our society towards a more circular reality. Its vision is a future where biobased components of waste—from industries like textiles, agriculture, and forestry—are transformed into biological nutrients and then regenerated into new chemicals and materials through microbial fermentation.

This **Progress Report** celebrates the strides made by the Alliance in 2024, including the first versions of the Materials BioCircularity Database and critical steps toward formalizing Membership and governance. As Members work together to achieve these goals, the Alliance, led by Spiber as its Steward, continues to promote adoption of biocircularity principles across industries, with textiles as the initial focus.

Metabolic Recycling: Unlocking the potential of biobased waste

Metabolic Recycling transforms biobased waste into biological nutrients, such as sugars and amino acids, which serve as feedstocks for microbial fermentation. These nutrients are then fed into microbial fermentation systems to regenerate valuable materials. This process unlocks the potential of biobased waste, and provides a practical, scalable pathway towards a circular bioeconomy where such wastes are regenerated into valuable products.

To the right; Figure 1: Metabolic Recycling process



These regenerated products can include:

Spiber's Brewed Protein™ fibers
for textiles and apparel

Biodegradable plastics
like PLA and PHAs

Renewable biofuels
such as bioethanol

Bio-based dyes and coatings
for a variety of applications

Unlike conventional recycling of biobased fibers—which often shortens fiber lengths or degrades polymers—Metabolic Recycling breaks waste down into its fundamental building blocks. These building blocks are then used to create recycled materials with quality that is equal to brand new.

This method complements existing recycling systems by focusing specifically on biobased waste streams, including challenging materials such as blended textiles (e.g., polycotton) and low-value agricultural byproducts.

By leveraging the natural processes of biological regeneration, Metabolic Recycling paves the way for a circular bioeconomy, where nature's ingenuity drives innovation and enables true fiber-to-fiber recycling, such as transforming textile waste into Brewed Protein™ fibers.



A vision for a circular bioeconomy



Ultimately, the Alliance aims for an end goal where mainstream products are designed and made from their inception to have their biobased components regenerated through Metabolic Recycling, thereby kept in circulation as biological resources after their end-of-use. Under this vision, designers and producers of apparel and other products will incorporate the principles of biocircular design into new products which they create. The Alliance will seek to move industries away from any chemicals and materials that reduce or hinder the ability for biological components of products to be metabolically regenerated at their end-of-use. Achieving this vision requires:

Developing **Product Design Guidelines** for designers and manufacturers.

Advancing **recycling technologies** to process biobased waste streams at scale.

Promoting **global awareness and advocacy** to support the policies and incentives necessary for biocircular production.

The Alliance serves as a catalyst for this transformation, uniting brands, manufacturers, and innovators to create a truly circular economy of biobased materials.

Summary of Achievements in 2024

The Alliance made significant progress in 2024, achieving key milestones that lay the foundation for advancing biocircularity:

Formalization of the Alliance: Defined the vision/objectives of the Alliance, and introduced a Membership framework and decision-making process.

Development of the Action plan: Created a shared roadmap to advance industry toward a biocircular economy.

Creation of tools for BioCircular product design: Laid the groundwork for a comprehensive public Database to provide industry stakeholders with valuable insights into the biocircularity of various materials and the impact of chemical substances used in their processing, supporting the design of products optimized for efficient Metabolic Recycling.

The following chapters look deeper into the steps taken to achieve each of these milestones, which represent the foundation for the Alliance's future work and its mission to create a truly circular ecosystem for biobased materials.



2. Formalization of the Alliance

The Alliance began as a project within Spiber Inc. to explore the possibility of using untapped biomass resources as a feedstock to replace conventional sugar based feedstocks. Early proof-of-concept work demonstrated the potential to produce Brewed Protein™ fibers from post-consumer textile waste containing natural fibers. This effort culminated in a collaboration with Goldwin to create a biocircular garment—a shirt made entirely from natural materials with full traceability of its components, offering a vision of seamless product design for Metabolic Recycling.

Figure 2: A demonstration product made with biocircular components



Members of the Alliance

11  brands

7  textile manufacturers

2  textile dye and chemical manufacturers

2  industry organizations

As of December 2024, a total of 22 Members of the BioCircular Materials Alliance include inaugural Members **Spiber**, **Goldwin Inc.**, **DyStar**, **Eileen Fisher**, **the Kering Group**, and **Pangaia**, as well as newly joined Members that the Alliance welcomed in 2024 in alphabetical order:

Albini Group
Archroma
Armedangels
Fashion for Good
Gruppo Florence
Marzotto Wool Manufacturing Srl
Marimekko
RDD Textiles
Stella McCartney
UNITED ARROWS LTD.
Vollebak

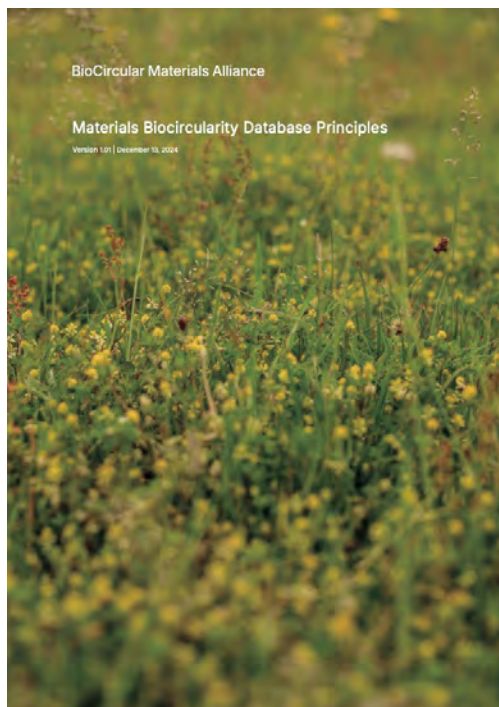
In addition to those listed above, other Member organizations have made valuable contributions to the Alliance but have chosen to remain anonymous. These include 2 anonymous brands, 2 anonymous textile manufacturers, and 1 anonymous industry organization.

The Alliance recognizes and appreciates the contributions of all its Members, both public and anonymous, in driving forward the shared mission of advancing biocircularity.

Working groups: Driving action

The Alliance's Working groups are at the heart of its efforts to achieve its long-term vision, objectives, and target outcomes for advancing biocircularity across industries. These groups, composed of Alliance Members who volunteer their expertise, focus on specific topics and challenges, providing a structured platform for in-depth discussions and collaborative decision making on key priorities.

Several Working groups have been established to address diverse aspects of the Alliance's mission, and have already delivered foundational outputs that define the Alliance's direction, including:



The Alliance Action plan: A shared roadmap outlining the long-term vision, objectives, activities, and outcomes for advancing biocircularity.

The Materials BioCircularity Database principles Creating a public data repository to provide insights into the biocircularity of various material and chemical combinations. This work complements the development of the Product Design Guidelines.

These outputs demonstrate the collaborative power of the Working groups, which bring together diverse cross-sector expertise to tackle shared challenges and achieve meaningful results.



As the Alliance's steward, Spiber has played a central role in facilitating the operations of the Working groups. Acting as a coordinator, Spiber drafts initial proposals and working documents based on input from Alliance Members. These drafts are then circulated among Working group Members for iterative review, discussion, and refinement. The process is highly collaborative, with empowered Members contributing their knowledge and expertise to shape the direction of the Alliance and to ensure the outputs are robust, practical, and aligned with the shared goals of advancing biocircularity.

Next steps: Building trust and preparing for the future

Inaugural Members of the Alliance, such as Kering and Goldwin, have played pivotal leadership roles in guiding Spiber during the formation of the Alliance, ensuring its direction aligns with broader industry priorities. Their input and feedback on the early drafts of the Action plan emphasized the importance of transparent and independent governance, underscoring the need for clear and collaborative decision-making processes.

The Alliance is designed to serve the public good, operating as a platform where Members contribute towards a shared goal. While Spiber currently acts as its steward, the Alliance is not intended to serve the interests of any single organization. Instead, its scope is far-reaching, supporting the development of guidelines and technologies to advance Metabolic Recycling solutions for a variety of biobased products across industries. Spiber's proprietary Brewed Protein™ fibers are one potential output that could be produced using metabolically recycled feedstocks, but the Alliance's work encompasses broader applications to benefit industries aiming to enable circularity for a wide range of biobased products.



As the Alliance continues to grow, further formalization of its structures will be essential to maintaining transparency, accountability, and long-term impact. This ongoing evolution will help dispel any misperceptions of the Alliance as serving only Spiber's interests, instead reinforcing its identity as a collaborative, industry-wide initiative. Strengthening these structures will solidify the trust and collaboration that underpin the Alliance's mission. Looking ahead, the Alliance envisions transitioning to an independent governance model, moving beyond its origins under Spiber's stewardship. This shift aims to establish a participatory framework where committed Members collectively shape the Alliance's direction. By empowering a broader group of responsible Members to take the lead in decision-making and strategy, this governance model will ensure the Alliance operates transparently, consensually, and with a shared commitment to advancing circularity.

To achieve this, the Alliance plans to form a **Working group for Transition to Independent Governance**, tasked with agreeing on a transition plan by the end of 2026. This milestone will mark an important step toward ensuring the Alliance's long-term sustainability and impact, reinforcing its position as a trusted and inclusive platform for driving innovation and collaboration.

3. Development of the Action plan

The [Action plan](#), developed collaboratively by Members of the Action plan Working group, outlines the long-term vision, objectives, activities, and outcomes for advancing Metabolic Recycling and biocircularity. Its significance lies in uniting a diverse group of industry leaders around a shared vision. By identifying specific gaps in recycling technologies, product design standards, infrastructure, and knowledge, the Action plan Working group has set a path forward for the Alliance to collectively drive meaningful change across industry to support designers and producers to adopt biocircular principles and to move away from materials and chemicals that hinder Metabolic Recycling processes.

Figure 3: Spiber, Kering and Eileen Fisher at a panel discussion about the BioCircular Materials Alliance at Biofabricate Paris, 2024





Key activities that have been identified include the following core areas:

Product Design Guidelines: Establishing clear recommendations for product creators and manufacturers to adopt biocircular design principles that will support Metabolic Recycling when incorporating biobased components into their products.

Materials Bio-Circularity Database: Building a comprehensive resource to complement the Product Design Guidelines by providing public data on the bioconvertibility of various combinations of common materials and chemical substances. It will be a resource for stakeholders to use in order to inform their decisions about material and chemistry selection for efficient Metabolic Recycling.

Process Scaleup: Supporting biomanufacturing partners in implementing and scaling Metabolic Recycling through knowledge sharing, resource mapping, and collaboration with industry and regulators to advance biocircularity.

Advocacy and Education: Publicly engaging product designers, manufacturers, industry organizations and policymakers to promote the transition to a biocircular ecosystem.

Members of the Action plan Working group

The Action plan Working group has benefitted from the input of the following companies and organizations (ordered alphabetically), as well as 3 other entities who have chosen to remain anonymous.

Albini Group

Archroma

Armedangels

Dystar

Fashion for Good

Goldwin Inc.

Kering

Marimekko

Pangaia

RDD Textiles

Spiber Inc.

Stella McCartney

Vollebak



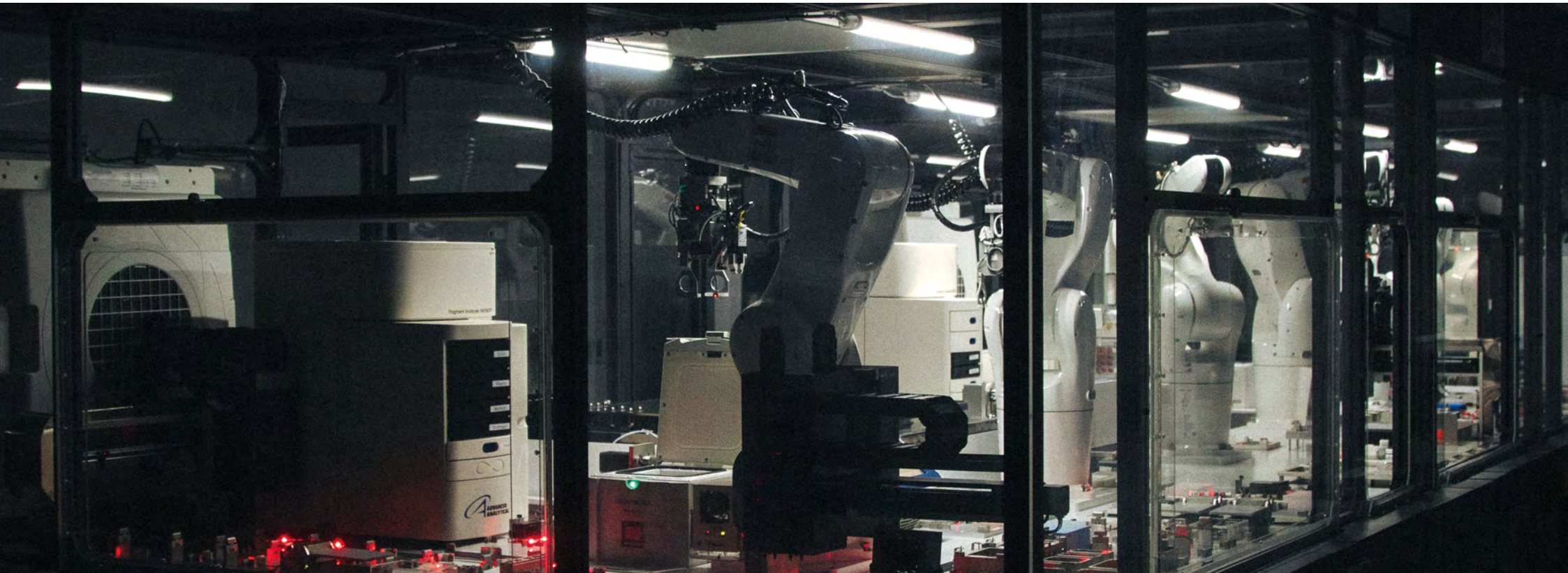
Next steps: Building trust and preparing for the future

Achieving the ambitious goals of the Alliance will require continuous reflection and adaptation. Members will periodically review the Action plan to assess progress and incorporate new insights, technologies, or opportunities that arise, and to be responsive to the evolving challenges while staying aligned with its mission.



4. Creating tools for BioCircular product design

The Alliance is actively advancing its mission to enable industries to shift toward biocircular product design through two key initiatives: the Product Design Guidelines and the Materials BioCircularity Database. These tools are designed to provide actionable data to product designers and manufacturers, while also serving as educational resources for industry organizations, policymakers, researchers, and other professionals to promote the adoption of biocircular practices and foster change across sectors.





In 2024, the Alliance prioritized the development of the [Materials BioCircularity Database](#) (the “Database”), a foundational tool to support biocircular product design across industries. Developed collaboratively by the Materials BioCircularity Database Working group, the Database compiles detailed datasets on the bioconvertibility of materials treated with specific substances, such as dyes and finishing chemicals. It serves as a comprehensive resource to understand how various combinations of materials and chemical treatments impact the compatibility of resulting products with Metabolic Recycling systems.

By systematically gathering and organizing data, the Database aims to close critical knowledge gaps and provide actionable insights to product designers, manufacturers, and other stakeholders. This tool will play a vital role in supporting the creation of products optimized for efficient recycling and regeneration.

The Database will complement the Product Design Guidelines by serving as a key resource for future users, helping them identify suitable material and chemical combinations for their biocircular product designs. Additionally, the data in the Database will play a crucial role in drafting the guidelines, enabling Working group Members to analyze test results and incorporate evidence-based recommendations into the guidelines’ content.

Database principles

The Materials BioCircularity Database Working group collaboratively developed the [Database principles](#), which form the foundation of the Database. This document, refined through a collaborative process and approved by Working group Members in 2024, outlines the testing methods and protocols used to evaluate the bioconvertibility of materials and assess the impact of specific dyes and chemicals. It also discusses the advantages and limitations of the chosen methodologies, and provides guidance on future directions and priorities for text improving and expanding the Database as more insights and resources become available.



Accumulating experimental data into the Database



As of the end of 2024, the [Framework Version of the Database](#) contains 31 screening level datasets. Each dataset represents the results of experiments analyzing and quantifying how specific processes—such as dyeing with a particular dye type or applying a certain type of softening agent—affect the bioconvertibility of a given Base Material.

The current datasets were generated through experiments conducted by Spiber Inc. They focus on cellulose-rich fibers, such as cotton, viscose, and lyocell, which have been evaluated for their compatibility with Metabolic Recycling after undergoing treatments with various dyes, softeners, and water repellents.

Key insights from data obtained in 2024



Early testing conducted at Spiber's lab has uncovered valuable insights, offering a glimpse of the transformative potential of the Materials BioCircularity Database.

One of the most significant findings from these early tests highlights the impact of dyes on cotton fibers' recyclability. Some types of dyes significantly hinder the fibers' ability to break down into sugars, a critical step in Metabolic Recycling, while others have minimal effect. These results shed light on how product design choices directly influence biocircularity, offering a preview of how the Database can guide product design in the future, demonstrating its immense potential.

This provides a valuable proof of concept, helping us envision how a more comprehensive Database will serve as a critical resource for designers and manufacturers in the future. Once further data is gathered and integrated into the development of the Product Design Guidelines, they will become powerful tools to drive real-world decisions that support biocircularity.

Alliance Members have expressed excitement about the value of this data, highlighting that, for the first time, they will have concrete and actionable evidence to guide their choices of dyes and chemicals. This newfound clarity will empower product creators to make informed design decisions that will support biocircularity.

Challenges and future considerations

Member feedback has been invaluable in shaping the Principles and identifying key challenges that require attention as the Database evolves:

Scaling testing capacity: While it's uncertain how much demand for datasets will grow, the Alliance recognizes the importance of planning ahead. Preparing for scalable lab-testing capacity will ensure the Database can accommodate future needs efficiently.

The realities of product use: Products face wear and tear, exposure to detergents, oils, and other residues during their use-phase, which can impact their biocircularity. Further exploration is needed to account for these real-world conditions and their effects on recyclability.

Microbial host diversity: The current protocols rely on use of specific microbes, but future Metabolic Recycling systems may use different microbial hosts based on their intended applications and feedstocks. Ensuring the flexibility of protocols will be crucial to maintaining the relevance of the Database across a range of host systems.

By addressing these challenges, the Alliance is committed to ensuring the Database remains a robust and adaptable resource for advancing biocircular product design. Staying ahead of these issues will help bridge the gap between theory and practice, ensuring the Database's long-term impact and relevance.

Next steps:



Looking ahead, the findings from the Database will play a key role in shaping the Product Design Guidelines—a resource the Alliance will develop to help product creators adopt biocircular design principles. These guidelines will offer practical, flexible recommendations for incorporating biobased components into products that Members can adapt to their specific needs and choose to follow as they see fit at their discretion. They will be designed to align with established standards like ISO 14006 (eco-design) and the EU codesign for sustainable products regulation (ESPR), ensuring they are both actionable and easy to integrate across industries. The Alliance plans to circulate a first draft of the guidelines to its Members in 2025, with a goal of achieving consensus among Members by the end of 2026.

The Alliance envisions these guidelines as a dynamic resource, evolving through continuous feedback from Members and external stakeholders. As new data is gathered and technologies advance, the Alliance will ensure that both the guidelines and the Database remain robust, relevant, and at the forefront of sustainable innovation.

Collaboration with the biomanufacturing sector will also be pivotal. As innovators refine and scale Metabolic Recycling technologies, they are expected to generate critical data to define precise criteria for acceptable feedstocks. For example, Spiber is already collaborating with partners to develop pilot-scale processes that use specific textile wastes as feedstocks for producing Brewed Protein™ fibers. The Alliance will work alongside these partners to harmonize the Guidelines with emerging requirements, ensuring compatibility with advanced recycling technologies.

By fostering these collaborations, the Alliance strengthens the link between brands designing for biocircularity and innovators driving the next generation of recycling solutions. This unified approach aims to build resilient cross-industry systems and infrastructure, laying the foundation for a circular bioeconomy where waste is transformed into opportunity, and biocircular manufacturing becomes the norm.



Members of the BioCircular Materials Database Working group

The BioCircular Materials Database Working group has benefited from the input of the following companies and organizations (ordered alphabetically), as well as 4 other entities who have chosen to remain anonymous.

Albini Group

Archroma

Armedangels

Dystar

Eileen Fisher

Fashion for Good

Goldwin Inc.

Gruppo Florence

Kering

Marzotto Wool Manufacturing Srl

Marimekko

Pangaia

RDD Textiles

Spiber Inc.

Stella McCartney

Vollebak

5. Call to action

The BioCircular Materials Alliance invites you to be part of this transformative journey toward a biocircular future. Whether you're a designer or manufacturer in the textile industry or beyond, a biomanufacturer advancing processes, a policymaker, journalist, or other stakeholder, your expertise and passion can help drive meaningful change.

To learn more or get involved, visit our website at <http://biocircularmaterials.org/> or contact us at contact@biocircularmaterials.org.



6. Acknowledgements

The Steward team extends its heartfelt gratitude to the many industry stakeholders and individuals whose contributions have brought this initiative to life. Countless people have shared invaluable feedback—both formal insights and candid constructive criticism—that have helped refine and strengthen the Alliance’s efforts. Listed below are names of those who have given permission to be mentioned publicly, but there are many others who have chosen to remain anonymous. We could not have done it without you! Together, this collective commitment is shaping the future of a biocircular economy.



Alliance Members' teams



Albini Group- Marco Raganato

Archroma- Anjani Prasad, Patrice Carreau, Rasika Chatterjee, Santosh Surve

Armedangels- Päivi Eräpuu

Dystar- Dr. Benjamin Chalmers, Melissa Hamza, Fanny Vermandel

EILEEN FISHER- Xiaofei Li, Inka Apter

Goldwin Inc.- Masaaki Murata

Kering- Christian Tubito, Caterina Tonda

Marzotto Wool Manufacturing Srl- Giorgio Todesco, Roberto Lovo, Paolo Consolandi, Vincenzo Tumino (Raw Material Purchasing), Davide Cracco

Gruppo Florence- Vittorio Branchizio, Marco Rudigari, Raffaella Scimeca, Valentina Boffi

Pangaia- Chelsea Franklin, Blathnaid Geoghegan, Tilly Bintley-Bagot

RDD Textiles- Rute Santos and Barbara Leite

Spiber Inc- Akane Asai, Ayana Nakajima, Hisako Kanazawa, Kazuhide Sekiyama, Keisuke Morita, Keita Awaji (former Spiber Member), Noriko Fukushima, Sineenath Kunthiphun, Soichiro Ogawa, Toru Takahashi, Viet Linh Dao and the many other Spiber team members whose collective efforts have been instrumental in advancing the Alliance's progress. We also wish to thank Ali Schachtschneider, a former core member of the Steward team, for her invaluable contributions during the early stages of this initiative.

Stella McCartney- Inês Ribeiro, Peter Nasielski

UNITED ARROWS LTD.

Steward

The Steward team at Spiber is made up of the following individuals.



Aditya Sharma

Aditya is leading the engagement with Alliance Members and is based in Japan. With a background in fashion design and a talent for fostering collaboration, he keeps the Alliance's network growing, meetings productive, and communications seamless—all fueled by his genuine passion for circularity. He advocates for an equitable governance of global resources including textile waste.



Chloé Mauduit

Textiles expert based in France, Chloé leads the lab work, experiments, and data analysis with creativity and a keen eye for precision. Her love for details—including making her own clothes—and pre-loved treasures drives her commitment to advancing the Alliance's technical progress with precision and efficiency. She aims to develop improved management strategies and solutions for the growing issue of textile waste.



Ted Varani

Based in France, Ted is the steady hand guiding the Alliance's development. A master of project management and operations, he excels at problem-solving and aligning diverse teams, turning ambitious ideas into real progress. His leadership ensures the Alliance stays focused and effective in driving its mission forward.



Kenji Higashi

Kenji, based in France and Spiber's Executive Vice President of Sustainability, brings over a decade of experience transforming biomaterials innovation from concept to reality. With a blend of strategic vision and scientific expertise, he leads the charge toward making biocircularity the standard, not the exception.

Contact

www.biocircularmaterials.org

Email: contact@biocircularmaterials.org

©Spiber Inc. All rights reserved.