IONCELL

making closed-loop textiles from wood pulp and waste materials

PROJECT DETAILS

Name: Ioncell-F

Website: ioncell.fi

Sector(s): Chemicals - industrial bio-materials / Textile Production

Project Partners: Aalto University, University of Helsinki, Andritz Oy, Metsä Fibre Oy, Marimekko, IKEA, Nokian Neulomo, Kering, H&M, Stora Enso

Project Duration: 01/01/2017 - 31/05/2017

Project Location: Helsinki, Finland

Key messages

- The Ioncell team has developed a closed-loop process that converts cellulose, a natural polymer derived from plants, into fibres for textile production without the use of harmful chemicals.
- Currently Ioncell's technology uses virgin wood pulp as its main input, but once operational at scale the technology can utilise discarded textiles enabling a circular textile production system.
- When producing circular materials it is crucial to have a good understanding of the value-chain requirements; a strategy for doing this, is to develop early on an advisory board with cross-sector stakeholders.
- Technological innovation alone is insufficient to transform existing production systems; it needs to be supported by other system elements (e.g. political commitment that helps unlock the required funding sources).

Introduction

Clothing sales have doubled worldwide since the start of the present century (1). In 2015, the fashion industry generated an estimated 1.7 billion tons of greenhouse gas emissions (GHG), and by 2030 this figure is expected to increase by 63% (2). These emissions are largely attributed to the production of raw materials for textiles (e.g. cotton) and to the fact that clothing is not recycled properly. At the end of its life, most clothing is currently thrown away with around 73% ending up in landfill or being incinerated. Of the remainder, 12% is recycled into lower-value items such as mattress stuffing or cleaning cloths. Less than 1% is recycled back into clothing (3) due to difficulties associated with collecting, sorting and recycling mixed textiles (4). On top of that, textile production consumes a big share of our planet's resources; for example, in 2015 the fashion industry used 79 billion m3 of water (5).

The circular economy can provide a solution to these problems. The circular economy refers to a restorative economic model, which seeks to extend the life of products, components and materials by keeping these in use within the economy for as long as possible. Circular strategies include, but are not limited to: eco-design, re-use, repair, refurbishment, remanufacturing, product-service systems and recycling. The potential benefits of implementing circular solutions in the textile industry are enormous.

One such solution is Ioncell, an innovative technology developed by Aalto and Helsinki Universities in Finland. Ioncell's process converts cellulose, a natural polymer and the main chemical component in plants, into fibres which can then be processed into yarn and textiles, creating a high-quality substitute for cotton and viscose (6) (see Figure 1). This is achieved using a solvent (ionic liquid), which can itself be reused in a closed loop. Currently the process uses virgin wood pulp as its main input but as operations scale up, Ioncell's technology will be used to turn waste textiles into new textile fibres. This novel circular solution has the potential to contribute to the displacement of not only cotton but also synthetic fibres (based on petrochemicals) which currently dominate the textile market.

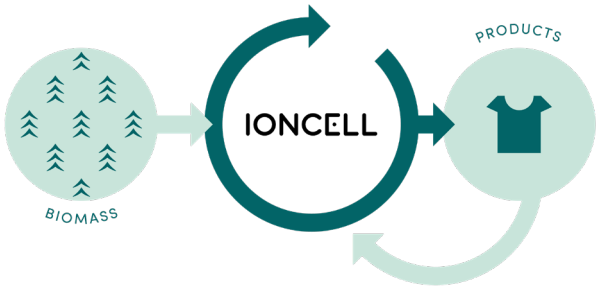

Figure 1: Ioncell technology can transform biomass into textile fibres. © Ioncell

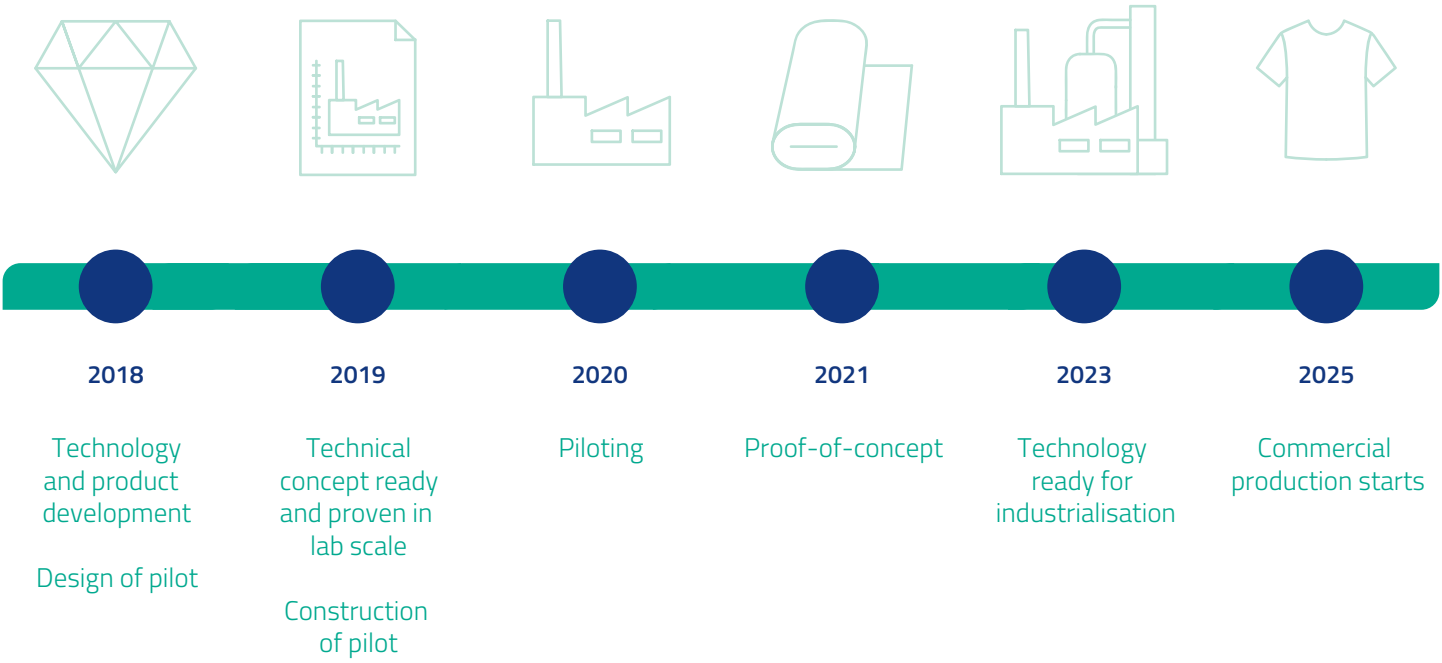

Figure 2: Ioncell's roadmap to commercialisation © Ioncell

Ioncell's business model

The Ioncell technology has been developed by researchers in the Aalto and Helsinki Universities over the last ten years, with support from various public funding sources (e.g. the "Trash2Cash" project under H2020 (7)). During this time, the team has been able to develop a lab facility at Aalto University, which currently produces around 100 g of fibre every day, using wood pulp – a renewable, locally-produced feedstock – as its raw material. The long-term aim is to use increasing amounts of discarded textiles as an input creating a viable alternative for the fibre market.

In 2016, the Ioncell team won a pitch award under the EIT Climate-KIC Nordic accelerator programme. Later that year, a 6-month collaboration started with EIT Climate-KIC, the 'Ioncell-F' project, which explored different business models for supporting the commercialisation of this innovative technology. The final decision on the appropriate business model for commercialisation will be made once their proof-of-concept is verified (see Figure 2).

The business model analysis took into account the fact that the technology still needs to be demonstrated at a larger scale, which will likely require public funding. The construction of a pilot facility is planned for 2019, which from 2020 onwards will be able to manufacture 10 kg of fibre a day. Ioncell's target is to have a commercial production plant with an annual production capacity of at least 50 kt by 2025 (see Figure 2).

Once this facility is up and running, Ioncell expects its product to be price-competitive with eco-grade cotton or viscose. The team sees the major environmental benefits of the technology stemming from the use of discarded textiles as an input, its use of a closed-loop manufacturing process that uses little water and energy, and the fact that the end product is fully recyclable and biodegradable.

In preparation for market entry in a few years, the team has already considered the benefits this technology provides to different stakeholders:
a) Pulp producers: opportunity to increase their raw material's added value
b) Yarn and textile manufacturers: improved environmental performance and eco-awareness
c) Waste collection operators: improved recycling rates

There are a range of possible ways Ioncell could generate revenue from the benefits their technology provides. However, this will depend on the commercial production pathway the team will select. For example, revenue potential will vary based on whether they decide to invest in building and running the commercial production plant themselves, seek collaborators to develop it or lease specialist equipment in order to produce and sell their circular fibres. Other strategic options could be to license or sell their technology. The Ioncell team is not ruling out any viable business models until after their proof-of-concept is verified.

System Conditions

With climate change requiring urgent and concerted action, there is a need to reconfigure and transform our economies and societies. Revolutionary technologies alone will not live up to the mark as they are not guaranteed access to market; it is often the surrounding environment that proves decisive on whether an innovation will flourish or perish. This is because the innovation is a part of a wider system and influenced by key system elements, such as: Policy, Skills, Behaviour, Market Structures, Information Flows, Organisational Governance and Finance. Innovation needs to happen on all these fronts ('systems innovation') in order to achieve substantial system transformation.

Ioncell: Enablers

Policy

Strong political will has been a pivotal factor in the evolution of Ioncell's innovation. Finland has displayed leadership in this area, publishing in 2016 the world's first roadmap to a circular economy (8). Such political commitments send a clear signal to all stakeholders on the ground about where the economy is heading and the type of business models that will be encouraged. In turn, public financing bodies, like Business Finland, make investment decisions that are aligned with the national policy agenda. Business Finland's support has been critical in the development of Ioncell's technology and its path towards commercialisation (see Ioncell's website for overview of the SolvRec and iCom projects).

Organisational Governance

It is increasingly recognised in Finland that cross-sector collaboration is vital in order to extend the forest-biomass value chain to new applications in the textiles sector (9). In order to develop a deep understanding of their market, the Ioncell team has developed an advisory board comprising stakeholders from companies throughout the value chain (see Figure 3). The board brings together both large and smaller companies from the pulp and paper and the fabric industries, including IKEA, Stora Enso (one of the world's biggest pulp producers (10)), Andritz (a pulp-processing equipment producer, and Marimekko (a high-end, Finnish designer clothing brand).

This advisory board benefits both Ioncell and the participating companies. For Ioncell, it is a source of market information and business advice, as well as a way to nurture potentially profitable future business relationships. The larger companies can provide support in the form of funding, mentoring and product testing, while smaller companies offer speed and flexibility in joint activities. For the businesses themselves, it is an opportunity to meet in person other market players along the value chain and engage early with an innovative technology that can improve their business (by finding new markets for their by-product/waste streams, for example, and ensuring a source of sustainable material).

Once established, this advisory board requires constant upkeep and full-time coordination. Relationships have to be cultivated in order to maintain enthusiasm and ensure active involvement. It is very important to ensure that the group is running smoothly and any potential tensions eliminated; avoiding the involvement of direct competitors is a key consideration, for example.

Ioncell: Challenges

Information Flows

With groups that bring together researchers, academics and businesses, it is very important to ensure mutual understanding, as the commercial and academic spheres are different worlds: they operate at different paces and are driven by different sets of values and incentives. "They work at different clock speeds", says Jari Laine a doctoral candidate who has joined Ioncell to help with the business development process. "After one year the company is drumming its fingers on the table anxiously – 'Where are my results?' – while the academic is still writing articles for journals".

One of the key ways to bridge this gap at Ioncell has been the alignment of partners around a common goal – the project's circular economy aspect: "We are not just making fibres, we are saving the world," as Laine puts it. It is crucial to have a common understanding and to ensure that all parties are aware of what the team behind the innovation is trying to achieve – and how everyone else can best contribute. The establishment of both formal and informal fora for communication also helps to create better information flows and understanding among the stakeholders involved.

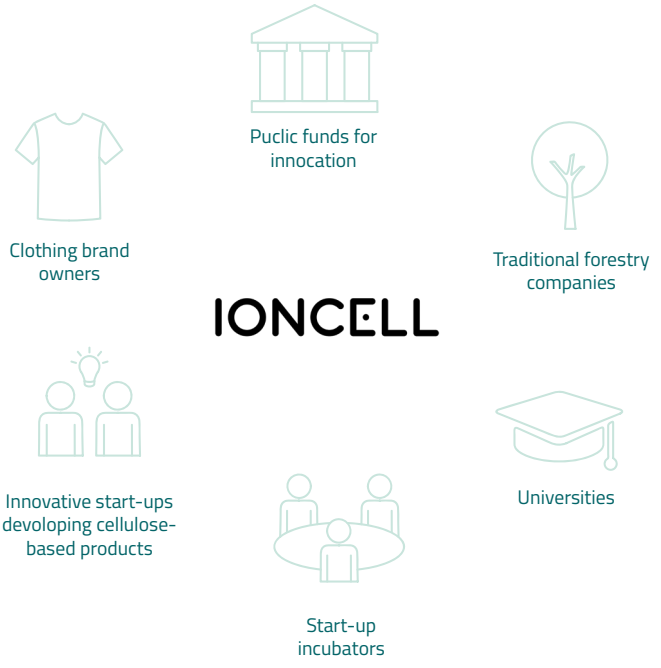

Figure 3: Ioncell's Innovation Ecosystem – Actors from the Forest to Textile Value Chain

Conclusion and lessons learnt

Ioncell's technology represents a promising circular solution for textiles, one of the most polluting industries, by ultimately enabling the upcycling of discarded textiles into new fibres.

A favourable environment and calculated decisions have supported the development of this innovation throughout the years, providing the team with new learnings and skills:

- **Strong political will is pivotal for the diffusion of circular innovation.** Political commitment to the circular economy provides a clear direction of what the future market is likely to look like, and therefore contributes to unlocking investment for circular solutions.

- **Commercialising research often requires long-term horizons and patient capital; circular technologies are no different.** Taking capital-intensive research projects to market tends to be a long-term endeavour; finding funders and business partners who understand longer time horizons for returns on capital is critical to success.

- **Good governance is vital; establishing a diverse advisory board early on can enable new ventures to understand their market and test key assumptions.** Ioncell have established a business advisory board that includes representatives from both large and small players along the full value chain, from forestry to fashion. If they are to prove beneficial for all parties involved, such boards must be established with careful planning and a dedicated coordinator must be assigned to ensure good communication.

- **Cross-sector collaboration and smooth information flows are crucial in scaling circular innovation.** Large and small businesses have different needs and require different incentives when it comes to engaging in new ventures like Ioncell. Understanding their motivations and investing in the development of clear information flows within these partnerships is fundamental to the success of Ioncell's ongoing commercialisation process.

After the development of a proof-of concept plant in the next two years, the team forecasts the start of commercial production around 2025. This will be a game changer for the textile industry, realising a new way to perform an existing activity: the production of textiles and clothes.

About

EIT Climate-KIC is Europe's largest public-private partnership addressing climate change through innovation to build a net zero carbon economy. The Climate Innovation Insights are one of the most knowledge sharing prominent formats of EIT Climate-KIC since 2016. Building on innovation endeavours of EIT Climate-KIC start-ups and partner institutions, the Insights are intended to share learnings and provide a platform for reflection and discussion.

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Endnotes:

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