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Producing apparel from waste oil: A challenge taken on by RadiciGroup through the “ULISSE” research project

A demonstration plant for industrial-scale production of polyamides (nylon) applicable to many production sectors, including fashion. Putting sustainability and circularity principles into practice.

An investment of almost EUR 6.2 million, of which a EUR 1.7 million grant from the Region of Piedmont

A pioneering objective: for the first time, to demonstrate the feasibility of **industrial-scale production of polyamides (nylon) starting from bio adipic acid obtained from renewable raw materials**, including waste oil and by-products of the oil industry. Potential application sectors for the process and products are textile/fashion, automotive, design, electrical and electronics.

This major sustainability-and-circularity-oriented goal has been achieved by RadiciGroup, an Italian multinational headquartered in Bergamo, a world-leading producer of a wide range of chemical intermediates, polymers, high performance engineering polymers and advanced textile solutions. The research was conducted through the **ULISSE project** and experimentation was performed in collaboration with research centres and universities. Partial funding was received from the Region of Piedmont, within the scope of the **“Call for Proposals IR2 (Industrialization of research results)”**.

The ambitious, innovative multiyear project was launched in March 2018 and stemmed from **RadiciGroup's desire to increase the sustainability of its products**, whilst delivering the same quality and performance as required by product standards. What is more, the Group wanted to meet the demand coming from its various strategic sectors, in line with the European targets for the development of **low-emission businesses and a circular economy**.

The funding amounted to EUR 6.2 million, of which EUR 1.7 million was contributed as a grant by the Piedmont Region. This investment confirms RadiciGroup's great commitment to scientific research, which is strongly supported by the Group's shareholders.

*“RadiciGroup's commitment to the ULISSE project, carried out thanks to the facilities of Radici Chimica and the research and innovation expertise of Radici InNova,” commented **Stefano Alini, CEO of Radici InNova**. “confirms the strategic importance of sustainability, which has always been part of the Group's DNA. Sustainability principles accompanied the project all through its development process. First, waste oil becomes a raw material for the production of adipic acid, which in turn serves as the base material for the production of polyamide polymers, the key*

ingredients for the manufacture of components. Finally, the components are fully or partially recycled at the end of their useful life.”

Mr. Alini continued: *“In this way, the circular economy cycle is completed, thus responding to the demand coming from an ever-increasing number of customers, especially those in the world of fashion and textiles, who are very sensitive to the environmental impact of products. These customers are requesting the development of new materials that can also meet the sustainability goals at the national and EU level, such as Agenda 2030 and the Green Deal. The concept of bioeconomy fits perfectly into the RadiciGroup sustainability programme, in which the careful use of raw materials and resources is of vital importance.”*

The ULISSE project focused on **three main areas of research**, all of which had the same general approaches: firstly, the experimental processes developed within the ULISSE project framework were **industrialization oriented**; secondly, they had a **strong innovative component**; and, lastly, they **implemented the principles of sustainability** and the circular economy in real-world applications.

The first area of research concerned the design and construction of a **polymerization line** for the industrialization of a range of innovative bio-based, high-performance polyamides. For this purpose, a production plant on a semi-industrial scale was developed; it is highly versatile, capable of limiting production waste while, at the same time, meeting the requirements of many sectors, such as fashion, automotive, textiles, contract, industrial, electrical and electronics.

The second area of research, using the above production line, developed a process for the **production of partially or fully bio-based polyamides**, that is, polyamides partially or fully obtained from renewable raw materials and high-performance **specialty polyamides**. More specifically, among the fully bio-based polyamides, the demonstration of the production of PA56 on a semi-industrial scale was a world first. The polyamides have varying characteristics and different levels of performance, making them suitable for use in different sectors: **partially or fully bio-based polyamides** are used, particularly in textile/fashion (for instance, technical sportswear), furnishings, automotive and electronics, while specialty polyamides are being developed to withstand high temperatures.

Finally, investigations were carried out on the feasibility of **using biotechnology to produce adipic acid** – a chemical intermediate used in the production of polyamides, polyesters and polyurethanes – **from renewable sources** (waste oils and by-products of the oil industry). That research created from scratch an alternative technology for a process whose chemistry had remained unchanged since the 1930s. As part of the project, a few tons of bio adipic acid were produced, with the support of Rynetech Bio, an American company with vast experience in the field of industrial biotechnologies.

This collaboration has made it possible to acquire and bring to Italy, and particularly the Piedmont Region, significant skills, **know-how and technologies in the field of fermentation processes** and **knowledge in the field of molecular biology and genetic engineering** for the synthesis of chemical intermediates from renewable sources. The next challenge will be to achieve the actual industrialization process, making the possibility of producing a fashion item from waste oil a reality.

Thanks to the processes tested as part of the ULISSE project, RadiciGroup is set to become one of the first groups in the world to offer the market a range of polyamides boasting outstanding sustainability and circularity characteristics, with an estimated **polymerization line production capacity of about 4,000 tonnes per year**.

Special mention goes to the environmental aspects of these new polymers made from renewable raw materials. which make this research activity one of the most advanced in promoting the fight against climate change. The carbon of biological origin contained in these polymers is actually incorporated into the polymeric materials, which are practically infinitely recyclable. Therefore, the release of the incorporated CO2 into the atmosphere is avoided during the materials' full life cycle, and an important objective in the ecological transition is achieved.

Finally, the ULISSE project has also had a positive effect in terms of employment. An advanced training project and an apprenticeship programme were completed with the goal of filling 5 new positions (researchers and technicians), specifically, a chemical engineer, an industrial engineer, a biologist and 2 chemical technicians, with a consequent positive impact on the company's organizational structure and community. The new positions will be involved in areas related to the ULISSE project. In the long term, it is estimated that other human resources may be added to handle the polymerization line.



RADICIGROUP – With approximately 3,000 employees, sales revenue of EUR 1,019 million in 2020 and a network of production and sales sites located throughout Europe, North America, South America and Asia, RadiciGroup is one of the world's leading producers of a wide range of chemical intermediates, polyamide polymers, high performance engineering polymers and advanced textile solutions, including nylon yarn, polyester yarn, yarn made from recovered and bio-source materials, nonwovens and personal protective equipment for the healthcare field. These products are the result of the Group's outstanding chemical expertise and vertically integrated polyamide production chain and have been developed for use in a variety of industrial sectors, such as: automotive – electrical and electronics – consumer goods – apparel – furnishings – construction – household appliances – sports. The basis of the Group's strategy is a strong focus on innovation, quality, customer satisfaction and social and environmental sustainability. With its business areas – Specialty Chemicals, High Performance Polymers and Advanced Textile Solutions –, RadiciGroup is part of a larger industrial group that also includes textile machinery (ITEMA), energy (GEOGREEN) and hotel (SAN MARCO) businesses.

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