DOI: http://dx.medra.org/10.17374/CI.2019.101.6.40

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A NEW BIOECONOMY INFRASTRUCTURE

Mater-Biopolymer is the most recent bioeconomy infrastructure of Novamont Group, dedicated to the production of Origo-Bi, a biodegradable biopolyesters of renewable origin. The plant represents another virtuous example of the group's development model, which looks at the bioeconomy as a factor of territorial regeneration.

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The linear economy model has already demonstrated to create high environmental, social and economic costs, producing large quantities of waste of resources, without actually being able to provide a response to global challenges such as climate change, resource scarcity, greenhouse gases (GHG) emissions, soil erosion and desertification, water pollution. Since its foundation Novamont has been believing that the circular bioeconomy could be the answer to some of these serious problems that currently affect our planet, reconnecting technology, society and the economy. In a circular economy perspective, bioeconomy represents the fundamental innovation that allows moving from an industrial production based on the use of fossil resources to one based on the use of renewable sources, closing the carbon cycle and regenerating local areas. For Novamont this means boosting competitiveness through a model of continuous innovation applied to the territories and their specific features and concerns **[1]**.

Novamont is a bioeconomy pioneer and an international leader in the bioplastics sector and in the development of biochemicals and bioproducts obtained from the integration of chemistry, agriculture and the environment. It promotes a model of bioeconomy as a factor of territorial regeneration, based on three "pillars". The first one is the reindustrialisation of no longer competitive or decommissioned plants through world-first proprietary technologies to create "bioeconomy infrastructures", integrated with the territory and interconnected with each other. In this way, Novamont contributes to regenerate industrial and rural areas at risk of abandonment, with positive effects on employment and local economies, while reducing environmental impacts, preserving virgin land from soil consumption, and contributing to the reduction of CO_2 emissions through the energy efficiency of the plants and the valorisation of process waste. Examples of this kind of regeneration are Mater-Biotech, the company born from the reconversion of a decommissioned industrial site in north-east Italy into the first dedicated industrial plant at world level to produce bio-butanediol through fermentative processes and Mater-Biopolymer, a plant located in central Italy which produces biodegradable biopolymers as a result of the conversion of a PET production plant (Fig. 1).

Fig. 1 - Mater-Biopolymer plant dedicated to the production of Origo-Bi biopolyesters - Patrica, Lazio

The second pillar is represented by low impact agricultural value chains, connected with the bioeconomy infrastructures and integrated in the territories, which are based on sustainable practices, respect biodiversity and aquatic and terrestrial ecosystems and valorise marginal land. With this approach Novamont makes sure that production of renewable raw materials does not occur in soils with high biodiversity and high carbon reserves, promoting good agricultural practices, such as the use of compost, an organic soil improver that can naturally restore soil fertility.

The third pillar is represented by products conceived and designed to reduce environmental impacts and preserve natural resources such as water and soil. This is the case of biodegradable and compostable bioplastics, biolubricants, bioherbicides and biodegradable cosmetic ingredients (Fig. 2, 3).

Mater-Bi is the range of bio-based, biodegradable and compostable bioplastics, developed by

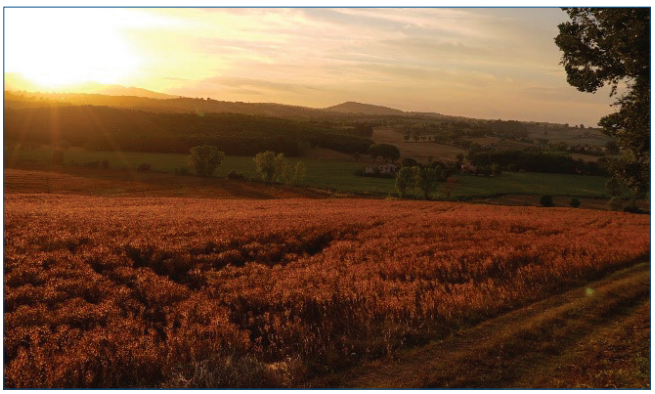

Fig. 2 - Safflower fields

Fig. 3 - Cardoon flower

Novamont research to provide solutions to certain environmental, economic and social problems, such as in the managing of the organic waste collection, or in sectors where there is an high risk of dispersion in the environment, as in the case of applications for agriculture. Compostable shopping bags, for example, can substitute the traditional plastic bags, so that they can be used for the collection of organic waste, avoiding biowaste to be mixed with plastic and creating a positive impact on the quality and quantity of waste collected. This dual use allows at the same time to reduce the number of plastic bags that are thrown away or end up in landfill. With the use of bioplastic bags, organic matter can be converted from waste to compost, a valid soil improver, closing the carbon cycle, combating soil desertification, reducing the amount of water needed for agriculture, limiting the effects of eutrophication due to the use of chemical fertilizers and increasing plants resistance to disease **[2]**. Another example is provided by compostable food serviceware, which is another interesting area for bioplastics, since it allows to increase quantity and quality of biowaste collection in closed and controlled systems, such as events and canteens. The use of compostable dishes and cutlery is the perfect example of applications for which bioplastics are crucial and for which traditional plastics should be avoided in order to improve the quantity and quality of waste collection. In fact, traditional plastic cutleries and dishes should be cleaned and separated from the

Fig. 4 - Examples of applications made of Mater-Bi (bags for waste management, shoppers, food-packaging, foodserviceware etc.)

organic part and usually are not differentiated, while the use of compostable bioplastic foodservice allows to collect all the waste deriving from food consumption in the same organic bin. Another interesting application of bioplastics are biodegradable mulching films, which can be processed directly in the soil avoiding the accumulation of plastic material. They don't have to be disposed, reducing the production of plastic waste, and the environmental impacts related to the not properly removal of traditional plastic films. They maintain the same agronomical performance as the conventional black plastic film and can also be used on crops not normally mulched with plastic, like tomato, rice and vine (Fig. 4).

The biorefinery model promoted by Novamont, developed over years with a view to upstream integration as far as the agricultural sector, today is composed of 6 interconnected sites and 4 proprietary technologies fully industrialized. The first important technical result of Novamont's pioneering activity in the starch-based materials sector is the complexation of starch due to the effect of insoluble hydrophilic-hydrophobic polymers. The relevance of the invention lies in the possibility of transforming starch, an energy resource for plants, into a range of materials with mechanical properties and processability very similar to traditional plastics. This technology gave rise to the first-generation Mater-Bi **[3]**. The second invention was the process to obtain biodegradable polyesters (Origo-Bi) from vegetable oils, that allowed the birth of the II-generation of Mater-Bi. The two last great innovations that led to the 4th generation of the Mater-Bi are a unique process for the oxidative cleavage of vegetable oils for the obtainment of saturated carboxylic acids, such as azelaic acid, used as a building block for the production of Origo-Bi and a unique one step biotechnological process to obtain the bio-butanediol (1,4 bio-BDO) from the fermentation of sugars, using a specifically engineered *Escherichia coli* strain **[4]**.

Today Mater-Bi is preparing for a 5th generation with an increasing renewable content (Fig. 5).

Novamont is also developing a series of synergistic products such as biolubricants and greases that, if spilled in the environment, do not reduce soil fertility, do not accumulate toxicity in the groundwater and biodegrade in few days; biodegradable bio-herbicides for the management of weed control that combine productivity, safety and respect for the environment, based on pelargonic acid of vegetable origin and a line of biodegradable ingredients for cosmetic applications with high level

Fig. 5 - Mater-Bi

technical performances, “readily biodegradable” in accordance with OECD guidelines, which allow to avoid the contamination of sewage sludge and the dispersion of microplastics into the waters.

Mater-Biopolymer: the most recent bioeconomy infrastructure of Novamont Group

Mater-Biopolymer plant was born with the name SIPET in 1990 with the start-up of the construction of the first plant for the production of PET, thanks to a joint venture between Shell and the M&G (Mossi & Ghisolfi) Group. The plant was completed and came into production in 1992. In 2000, with the acquisition of all the PET business owned by Shell, of which SIPET was a part, SIPET changed its company name to M&G Polimeri Italia. Over the years, following changes in the market, the production lines at the Patrica (FR) site became too small for the PET market and one of the two lines was shut down in 2009. The Patrica plant was recognised as being a highly advanced and efficient plant at European level, also having strong technical skills, but it was not integrated upstream and it had become at that stage too small for the economies of scale in M&G’s production of PET. Between then and 2009 a cooperation began between Novamont and M&G for a complex project with the aim of establishing the transferability of a batch technology developed by Novamont. This cooperation gave origin to an important know-how, with the first start-up of continuous industrial production of Origo-Bi in 2011. This start-up was followed by a number of modifications, which resulted in the definition of the present technology and in the configuration of the first production line. The second production line, instead, continued to manufacture PET for M&G as long as it was possible, that is until early 2017 **[5]**.

The conversion of the first production line from PET to biopolymer was followed in 2018 by the conversion of the second production line: today the nominal bio-polymer production capacity is around 300 tons/day **[6]** (Fig. 6).

Origo-Bi is a family of polyesters resulting from a number of proprietary technologies developed by the Novamont’s research center in Novara and subsequently industrialized in the Terni site, which can be used in the production of biodegradable and compostable Mater-Bi bioplastics. Origo-Bi increases the range of obtainable properties of Mater-Bi, and as a consequence the range of possible applications. They also make it possible to use different monomers of vegetable origin, which the Novamont technologies are allowing and will allow to produce, as an essential link between Mater-Bi and the upstream value-chain. The bio-butanediol (1,4 BDO) is one of the main ingredients required for the formulation of Origo-Bi and is provided by Mater-Biotech plant in Bottrighe (RO).

Fig. 6 - Mater-Biopolymer plant

The two polymerizations lines, BG1 and BG2 are the heart of the plant. The polyester production is carried out by multistage process both in esterification and polycondensation stage.

During the esterification step a part of butanediol undergoes a cyclization reaction giving rise to tetrahydrofuran (THF).

A stream of water, THF and organic solvents collected as by products, are treated in a distillation plant for the recovery of THF. Pure THF is intended for the chemical and pharmaceutical industries, where it is used as a solvent and an intermediate for the production of various products such as elastic fibres.

In a circular economy perspective, Mater-Biopolymer is a highly efficient plant capable of ensuring quality, environment and safety requirements, and has a complex system of utilities which makes it possible to minimize costs and wastes through

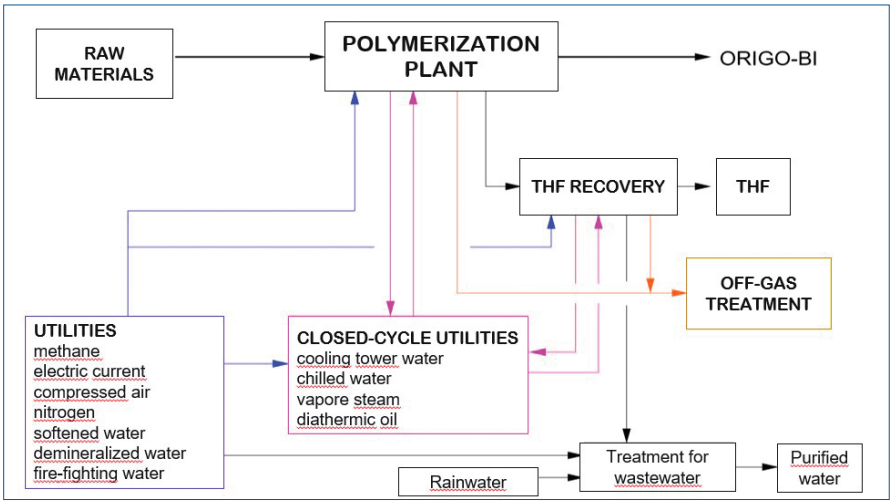

Fig. 7 - Bio-Polymer plant's utilities

the recovery and reutilization of wastes. Other projects are at the investigation stage. Inside the plant there are different utilities systems at the service of the main plants, with the aim of ensuring the quality, environment and safety requirements. In particular, closed-cycle utilities are based on the concept of minimizing costs and wastes, recovering fluids and conditioning them to be reintegrated into the cycle. In support of these there are the utilities that, through a transformation, allow the operation of all the plants.
This complex system of utilities, the high efficiency, and the enhancement of the co-products make Mater-Biopolymer a virtuous example of sustainable development of the Novamont's development model, which considers bioeconomy as a factor of territorial regeneration (Fig. 7).

For further information see:
https://www.novamont.com/
http://materbi.com/

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Una nuova infrastruttura di bioeconomia

Mater-Biopolymer è la più recente infrastruttura di bioeconomia del Gruppo Novamont dedicata alla produzione di Origo-Bi, un biopoliestere biodegradabile di origine rinnovabile. L'impianto rappresenta un altro esempio virtuoso del modello di sviluppo del gruppo, che guarda alla bioeconomia come un fattore di rigenerazione territoriale.