

Cellulose microfibrils (MFC) with controlled polarity

DESCRIPTION

The project consisted of developing a technology for the manufacture of MFC with controlled polarity, for its subsequent application as a reinforcing additive in resins, both hydrophilic and hydrophobic. To do this, the surface of the MFC was controlled by acetylation, to change its surface polarity and optimize its compatibility with matrices of diverse chemical nature. Then, the reinforcing capacity of the reinforced MFCs in adhesive resins of the urea-formaldehyde type (UF) and in plastic resins of the polypropylene type (PP) were demonstrated.

ADVANTAGES

1. The physical and chemical characteristics of the MFCs produced during the project allows them to be dispersed homogeneously in hydrophobic polymer matrices, unlike conventional MFCs, whose polarity makes them incompatible with these materials. Although there are similar proposals mentioned in the technical literature, the product developed stands out for its low cost and better reinforcing performance in polymers of different polarities.
2. Regarding the developed process, its main differentiating attribute is that it allows a homogeneous substitution of hydroxyl groups present in MFCs, unlike conventional processes that are difficult to control. In fact, acetylation of macro fibers tends to be heterogeneous, with preferential substitution at the surface level, which damages the properties of microfibrils. For its part, a fibrillation at a micro and nanometric level allows to increase the homogeneity of the material, improving its properties, facilitating its dispersibility in thermo-rigid and thermoplastic resins.
3. The plastics reinforced with the developed product show a greater elasticity than their equivalents without modification, whose incorporation into plastic matrices usually deteriorates the mechanical properties of the material.
4. MFCs are capable of greatly improving the adhesive properties of commercial urea resins. This allows reducing the dosage of adhesive required for the manufacture of particle board, without compromising its mechanical properties.



▲ (i) CFM pilot plant - (ii) ABES UF resin test with CFM

MARKET

Plastic processing industry: The addition of acetylated MFC allows to improve the characteristics of the material against tensile stresses, which translates into greater resistance to breakage. This improvement is of special interest to plastic processing companies and users that require PP with better mechanical performance. The only PP producer company in the country, Petroquim S.A., have expressed interest in this technology.

Adhesive resin industries: An increase in the degree of acetylation improves the reinforcing effect of the MFC, resulting in an increase in the mechanical resistance of adhesive resins. This effect has caught the attention of the company Resinas del Bío-Bío S.A., which has shown interest in the product. Its intention is to take advantage of the reinforcing effect and the low cost of MFCs, to generate a new product that allows reducing the dosage of adhesive resin required in the manufacture of reconstituted wooden boards.

APPLICATIONS

A correct control of the polarity of the MFC allows diversifying the range of materials that can be reinforced. In other words, the developed process opens the doors to a series of applications, in which traditional MFCs do not perform well. Among them, in paints, varnishes and concrete; food thickener, emulsion stabilizer, cosmetic component and surfactant replacement; and also flexible electronic displays, wound healing material or 3D printing material.



▲ MFC-reinforced PP extrusion

TECHNOLOGY DEVELOPMENT STATUS

Functional prototype. The MFC production process, including acetylation, was tested at the bench-scale level. The process is currently being scaled to a pilot-demonstration level.

INTELLECTUAL PROPERTY

- Current status: In patent process
- Technology owners: Universidad de Concepción and Fundación COPEC-UC

INVENTORS



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OPPORTUNITY

The world pulp market is becoming more competitive every day, due to the decrease in demand for printing and writing papers. Therefore, it is important to tend to diversification and the development of new applications. In this context, you must add new functionalities to the paper, or use the fibers for other uses. New products developed by this industry include microfibrils, cellulose nanocrystals, and composite materials. Its value lies in its biodegradability, biocompatibility, low cost and high versatility.

Along with the technical and economic advantages, the application of acetylated MFC has the following environmental and ecological benefits associated:

The plastics industry is facing an increasingly aware citizenry of the harmful environmental effects associated with the use of fossil plastics. This is due to its very slow degradation in nature. Although the use of plastics is being restricted in single-use applications (for example, packaging bags, disposable cutlery and light bulbs for soft drinks, among many others) and that biodegradable plastics are slowly entering the market, the reality is that humanity must continue to live with fossil plastics for many more decades, since their elimination / replacement will be gradual and slow processes. The consumption of plastics in Chile is 50 kg / inhabitant / year, while in developed countries the annual consumption per capita is three times higher. Furthermore, urea adhesives use formaldehyde as one of their main components. It is a compound classified as a carcinogen by the World Health Organization (WHO). While the polymerized adhesive is not dangerous, as formaldehyde reacts during curing and becomes part of a crosslinked polymer, the use of a highly hazardous raw material and the very low formaldehyde emissions from the cured adhesive are very serious environmental concerns, for both producers and users.

PROJECT ACKNOWLEDGMENTS

We recently started executing the CORFO Alta Technology project "Development of technology for the production of chemically modified cellulose nanofibers (NFC), for applications of high economic interest and global impact", the main objective of which is to scale the process, to apply it industrially.

FOR MORE INFORMATION



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▶ **Ciencia, Tecnología e
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