Plastics sustainability: Synthesis of CO2- and bio-based polycarbonates and polyurethanes

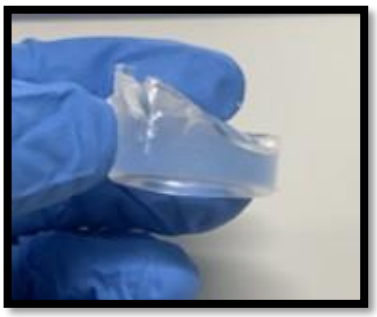
The European Union has set ambitious goals to reduce CO2 emissions by 55% before 2030 to achieve a carbon-neutral economy by 2050. In addition to efforts focused on energy decarbonization, it is essential to decouple the production of polymeric and plastic materials from fossil fuels. **TECNALIA** has contributed to this objective by utilizing CO2 in polymer synthesis, thereby transforming an environmental issue into a valuable raw material — turning a problem into an opportunity.

Polycarbonates

Currently, most polycarbonates are non-renewable, non-biodegradable, and derived from bisphenol A (BPA), raising concerns about the potential health effects associated with BPA exposure. CO2-based polycarbonates are an excellent opportunity to turn CO2 into a valuable product. However, the conventional BPA-based polycarbonates exhibit mechanical properties that current CO2-derived polycarbonates have yet to achieve.

TECNALIA has developed **new polycarbonates combining CO2 with rigid monomers derived from biomass**, enabling the development of polycarbonates with properties comparable to current BPA-based polycarbonates. Additionally, the use of biomass leads to the production of fully renewable polycarbonates.

Different biobased raw materials can be used, e.g., turpentine, which is a liquid extracted from coniferous -usually pine-, through distillation of resin. This oil is mainly composed by pinene and limonene; rigid molecules which can react with CO2 in a two-step process to originate 100% sustainable polycarbonates. Depending on the different conditions during the process (temperatures, catalysts, etc), polycarbonates are obtained with different properties such rigidness, molecular weight, tensile strength, transparency, etc., in order to be used in different applications like bullet-proof glasses, safety helmets, lenses, bottles, etc.

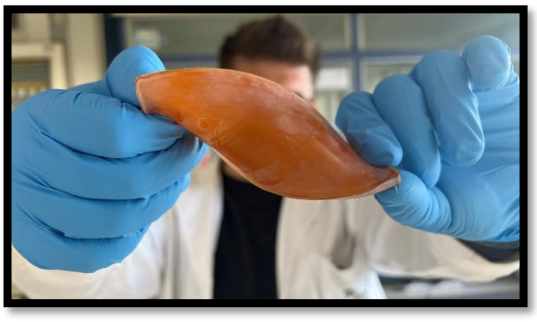


Polyurethanes

Polyurethanes are considered one of the most versatile materials in modern life, and it affords them to nicely suit for many applications such as paints, foams, clothing, adhesives, etc. However, polyurethanes include toxic materials like isocyanates or phosgene in their production.

Different polyurethanes can be synthetized from CO2, and **TECNALIA** has obtained **a CO2-based polyurethane derived from biomass; in particular; from vegetable oils.** These vegetable oils are transformed together with CO2 to obtain a sustainable **Non-Isocyanate PolyUrethane (NIPU)**. As for polycarbonates, different properties of the NIPU can be tuned depending on the synthesis conditions, obtaining materials for different applications such as coatings or

Innovative plastics have been produced from CO2; transforming this environmental concern into a valuable raw material. In particular, polycarbonates and polyurethanes have been synthetized, due to the toxicity of their traditional precursors. Together with CO2, different biobased monomers; such as vegetable oils and resins (pinenes, limonene, triglycerides, etc.), are used to obtain a 100% sustainable polymer. Properties can be easily tuned by optimizing some process conditions, e.g., monomers, catalysts, temperatures, etc.; obtaining polymers showing different rigidness, molecular weights, tensile strength, transparency, and much more in order to nicely suit in the desired application.



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