2nd Conference on Green Chemistry and Sustainable Coatings

greenchemco

Pisa, Italy, 28th-30th June 2023

Furan-based polyesters for biomedical, automotive and underwater applications

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Keywords: 2,5-Furandicarboxylic acid; processability; recyclability; biodegradation

Introduction

Plastic is produced worldwide and is everywhere present in our lives because it is versatile, light, durable, cheap to produce and useful in many different fields: biomedical, automotive, agriculture, transportation, packaging and aerospace. After two years of stalemate, linked to the Covid-19 emergency, global plastic production is growing again, and 390.7 Mt were produced in 2021, of which over 90% from fossil resources. The replacement of fossil-derived monomers with monomers derived from renewable sources is an important goal in view of a more sustainable production of plastics. The HORIZON-JU-CBE-2022-R-0-funded FURIOUS project joins 15 partners to explore ad hoc chemical design and synthesis of a new class of polyesters PXF), starting from high purity 2,5-furandicarboxylic acid (2,5-FDCA) monomer, extracted by agriculture waste polysaccharide feedstocks. The new PXF polymers will be specifically designed to have versatile properties, target processability and recyclability characteristics and will act as a valid alternative to best known furan-based polyester, the polyethylene furanoate (PEF), which is quite stiff and fragile, and this strongly limits its range of applications.

Objectives and ambition

FURIOUS project aims to synthesis high quality and high demanding products to be applied under severe conditions in three main fields: biomedical and electronical packaging, automotive sector (to realize caravan glass and air filters) and underwater applications (sensor sheaths and robot parts). The main idea is tuning the glycol moieties characteristics in the polycondensation reactions to modulate the final PXF properties according to their final applications: for biomedical and electronic packaging, resistance to sterilization and high barrier properties are required, coupled to tunable processability to cover both rigid and flexible films, for automotive sector high transparency, resistance to UV weathering and injection moulding processability are the key characteristics for the caravan glass production while intrinsic antibacterial properties and electrospinning processability are required for air filters achievement; for the extreme underwater environment, the photoreactivity and the biodegradability characteristics in seawater are the main properties to be evaluated together with the mouldability of the new polymers formulations by 3D

printing technologies. In the first instance, FURIOUS project will be devoted to obtain homopolymers, where 2,5-FDCA is combined with the most suitable glycolic monomer to get the set of properties necessary for the desired applications and to allow an easier recycling process and a better recovery of the starting monomers after enzymatic degradation. In case the target final properties are not achievable with homopolymers, copolymerization or reactive mixing will be adopted. Figure 1 summarizes the basic idea of FURIOUS project.

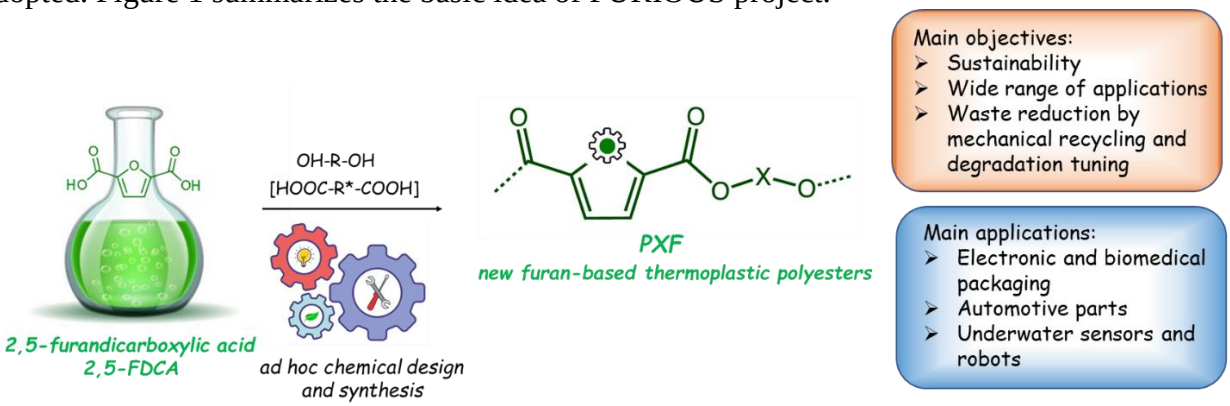

Figure 1. FURIOUS general idea and objectives

The University of Pisa involving

The University of Pisa (UNIPI) partner will be involved in obtaining PXF film for biomedical and electronic applications by blow-moulding extrusion on a pilot scale and in contributing to their thermal and mechanical characterization and it is significantly involved as WP Leader, together with National Interuniversity Consortium for Materials Science and Technology (INSTM) partner, in the optimization of furan-based polyester for automotive applications. UNIPI unit will contribute to selecting the best grade of furan polymers for the production of automotive components, and adjust the properties to meet automotive technical requirements. In particular, UNIPI action will be devoted to tuning furan-based polymeric formulation for setting properties for replacing poly (methyl methacrylate), PMMA, on transparent screens for automotive applications and for realizing antimicrobial air filters. UNIPI will also contribute to characterizing and validating the demonstrators produced by industrial partner LCI Italy Srl, LCI.

Acknowledgements: This project has received funding from the Bio Based Industries Joint Undertaking (JU) under grant agreement "GA101112541" project FURIOUS (Call: HORIZON-JU-CBE-2022).

Biography

Sara Filippi is an Associate Professor of Principles of Chemistry for Applied Technologies at the Department of Civil and Industrial Engineering, University of Pisa. She graduated in Chemistry in 1996 and PhD in Chemical Science in 2000. She has got good experience in organic synthesis, polymer modification, compatibilization, recovery and characterization of different kinds of materials She is the author of over 60 papers in international journals.