RETASTE Conference Abstracts
Vol. 2 RETASTE-PLW-250-Oral
Herakleion, Greece, 20-21 October, 2022

Biobased poly(ester amide)s from 2,5-furandicarboxylic acid and amido diols: sustainable food packaging applications and structure-properties correlations

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Abstract

It is estimated by the FAO that 768 million people in the world faced hunger in 2020 [1]. This fact is unacceptable, especially considering that food loss and food waste amount to about one-third (1.3 billion tons) of all food produced worldwide [2]. As part of the solution to this concerning environmental, social and economic issue, the innovation of food packaging materials is a strategy which can play a substantial role, extending the shelf life of food products, reducing food loss, food waste and their associated greenhouse gas emissions [2]. In particular, biobased polymers from waste biomass are a most relevant field of research: LCA studies confirm that the substitution of petrochemical plastics with biobased ones leads to a relevant decrease in CO_2 emissions [3], paired with no exploitation of agricultural land, and while supporting the sustainable development model of circular economy. In this framework, the aim of the present work was to investigate the functional properties of novel, previously synthesized, biobased and very promising poly(ester amide)s (PEAs) from 2,5-FDCA, containing different amounts of 1,10-decanediol and amido diols [4]. Both PEAs and the reference homopolymer, poly(decamethylene furanoate) (PDecF), were compression moulded into films and subjected to WAXS, TGA, DSC analyses and contact angle, mechanical, gas barrier tests. The results showed a remarkable improvement in the functional properties of PEAs compared to those of PDecF, with a decrease up to about 50% of O_2 and CO_2

transmission rates, values comparable to those of commercially available packaging materials. Most notably, the mechanical properties of PEAs were improved in comparison with PDecF, because of the increased toughness and higher resistance to plastic deformation, paired with an impressive elongation at break, up to 650%. From these insights, it was possible to establish scientific structure-properties relationships, confirming the suitability of this polymeric system for the production of biobased, sustainable, flexible food packaging. The high gas barrier and mechanical performances of PEAs were found to allow size-efficient, customizable design and increased shelf life for the prevention of food loss and food waste.

Keywords: Sustainable food packaging, biobased polyesters, 2,5-furandicarboxylic acid, mechanical properties, gas barrier properties

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