Current challenges in furan based polyesters from renewable resources

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Abstract

In recent years, the possible replacement of fossil fuels for the production of monomers from cheap and renewable raw materials such as cellulose, starch, lignin, proteins and vegetable oils is being extensively explored in order to develop a more sustainable "green" economy. In this context, bio-based polymers (polymers derived from renewable sources) have attracted the interest of industries and consumers around the world over the last 20 years. At the same time, European and American legislative frameworks change in favor of biobased products and at the expense of petrochemicals. The bio-based products sector is characterized as a key enabling technology by the E.U., and a priority area for development and funding.

One of the biomass-derived monomers that stands out in both academic and industrial research is 2,5-furandicarboxylic acid (FDCA). FDCA is produced by biomass from a series of sugar dehydration reactions towards hydroxymethylfurfural and its subsequent oxidation, and is mainly used for the production of biobased polyesters. Fully biobased polyesters can be synthesized from FDCA in combination with biobased diols that are already produced on an industrial scale. The FDCA-based polyester with the highest interest is poly (ethylene 2,5-furan dicarboxylate) (PEF), since it is thought to replace poly (ethylene terephthalate) (PET) in packaging applications as its biobased homologue. In that direction, the effect of several catalysts as well as of solid state polymerization on molecular weight increase of PEF was recently studied.

The study for the production of such polyesters has now been extended to other poly(2,5-furan dicarboxylate)s using aliphatic diols, sugar diols like isosorbide, benzylic structures like 1,4-bishydroxymethyl benzene, and bisphenols like hydroquinone, etc. This ongoing research and industrial production of such polyesters has been progressed in a new stage, in which polyesters with a very wide range of properties and hence of possible applications, can be readily prepared with high molecular weights and adequate mechanical properties. The progress that has been achieved during the last years and the contribution of our group is thoroughly highlighted in this presentation along with some of the most important thermal properties of the respective materials.