POLYMERS FROM RENEWABLE RESOURCES WITH APPLICABILITY IN THE PRODUCTION OF BALLISTIC PROTECTION EQUIPMENTS

NICOLETA PETREA[1]
RĂZVAN PETRE[1]
ALEXANDRU BOBEȘ TUREAC[1]
ANDRADA PRETORIAN[1]
FLORENTINA NEAȚU[2]

Abstract*: Polymers from renewable resources have been attracting increasing attention for three major reasons: environmental concerns, and the realization that our petroleum resources are finite, and relate to adding value to agricultural products, which is economically important. Starting from 5-hydromethylfurfural (5-HMF) - a platform molecule derived from biomass, using cheap, non-noble and recoverable catalysts, we tried to obtain furan based polyester (PEF) of high resistance, an important property for the polymers to be applied for ballistic protection equipments. PEF have similar physico-chemical properties with PET (polyethylene terephthalate) and we consider that it may replace PET in the ballistic protection equipments industry.*

Keywords*: biomaterials, HMF, FDCA, PEF, biodegradable, ballistic protection.*

1 Scientific Research Center for CBRN Defense and Ecology, 225 Olteniței Sos., Sector 4, 041309 Bucharest, Romania, nicoleta.petrea@yahoo.com
2 University of Bucharest, Department of Organic Chemistry, Biochemistry and Catalysis, 4-12 Regina Elisabeta Bvd., 030016 Bucharest, Romania, iosifflorentina@unibuc.ro

1. Introduction

The terrestrial biomass which Nature graciously provides us on an annual basis is considerably more complex than fossil raw materials, constituting a multifaceted accumulation of low- and high-molecular-weight products. By far, the most important class of organic material in terms of volume produced are carbohydrates, which represent the major biofeedstocks from which to develop industrially and economically viable organic chemicals and materials to replace those derived from petrochemical sources.

The PEF derived from biomass are non-toxic and biodegradable and, hence, have minimal impact on waste management. They can be safely incinerated and, by composting, can be returned to the ecosystem harmlessly, in a carbon dioxide-neutral process [1].

5-HMF is a versatile sugar derivative, which can be obtained from biomass in the presence of some non-noble solid acid catalysts. 5-HMF is the starting point for 2,5-furandicarboxylic acid (FDCA), a promising new biomass-derived chemical building block with a huge market potential [2].

FDCA has similar physico-chemical properties with PTA (terephtalic acid) and we consider that it may replace PTA in the production of polyethylene terephthalate used in the ballistic protection equipment industry [3].

2. Synthesis of FDCA from 5-HMF

The challenges faced by our researches were: i) to find a non-noble catalytic system for FDCA synthesis from HMF; ii) to find a stable catalyst, which could be recovered and reused; iii) to diminish as much as possible the base from the reaction media.

We studied the oxidation of 5-HMF with molecular oxygen in water, under heterogeneous base-free condition, using two non-noble catalytic systems: Mn_xFe_y oxide, and $Mn_xCu_yAl_z$. The catalysts were used as prepared, calcinated, and in the rehydrated form for a better comparison and were reusable at least three times without any significant loss of activity and selectivity. For Mn_xFe_y oxide, the reaction occurs by the rapid mechanism, while for $Mn_xCu_yAl_z$ the reaction occurs by both mechanisms (Figure 1).

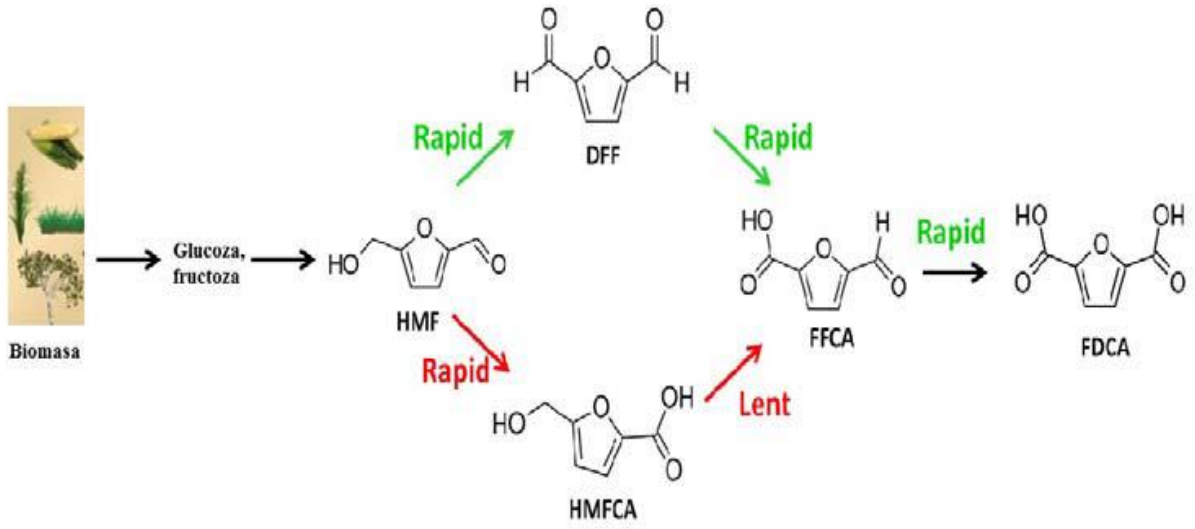

Figure 1. *The route of FDCA synthesis starting from biomass. DFF - diformylfuran; HMFCA - hydroxymethyl-2-furancarboxylic acid; FFCA - formylfurancarboxylic acid.*

3. Conclusions

FDCA synthesis in water was successfully realized in the presence of the non-noble catalyst based on Mn and Fe (70% selectivity, 100% conversion).

The FDCA synthesis prerequisite a basic medium to favor the FDCA desorption from catalytic sites.

The presence of Cu in the catalytic system favor the formation of HMFCA as intermediate, which means slowing the reaction rate.

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