Innovations and Industrial Technologies 2025

Polyurethanes from waste polylactide as an alternative to petrochemical thermal insulation materials

Joanna Paciorek-Sadowska, Marcin Borowicz, Marek Isbrandt

Department of Chemistry and Technology of Polyurethanes, Faculty of Materials Engineering, Kazimierz Wielki University

Kalisz, 23–24.10.2025

ABSTRACT

Polyurethane materials are particularly distinctive among applied plastics. Due to their exceptional performance properties, they are used in various industries, from medicine to automotive and civil engineering, often in extremely diverse and niche applications. However, polyurethanes are relatively expensive, mainly due to the cost of intermediates and crude oil. Therefore, and this takes on new significance in the context of the current global situation, alternative sources of raw materials are being sought. Increasing environmental awareness and tightening regulations regarding plastic waste are motivating scientists and entrepreneurs to invest in recycling technologies. Implementing strategies to limit excessive consumption of fossil fuels aims to reduce waste production, promote various economically viable recycling methods, and implement closed-loop policies. Such actions, undertaken by scientists, entrepreneurs, and consumers, can contribute to the sustainable development of the plastics sector. Polyurethanes (PU) have gained significant importance among the materials used worldwide. The possibility of producing sustainable polyurethane materials is currently being extensively explored, according to the available literature. This is achieved by partially or completely replacing petrochemical polyols with bio-polyols and eco-polyols. Bio-polyols are produced from two sources: vegetable oils and waste biomass, while eco-polyols are most often sourced from used plastic products. The aim of the presented research is to obtain thermally insulating rigid polyurethane foams with favorable performance characteristics, using polyol raw materials from poly(lactic acid) waste products. As part of the research, the effect of varying the content of eco-polyol, a product of polylactide glycerolysis, on the strength properties of the resulting materials was assessed. The study aimed to demonstrate the impact of glycerolysates based on waste PLA on increasing the thermal insulation efficiency of polyurethane materials, which could ultimately translate into reduced fossil fuel consumption, reduced CO2 emissions, and reduced smog. The use of high-performance thermal insulation materials also supports the pursuit of sustainable development and reduced greenhouse gas emissions, thus contributing to building a better future for all of us.

CONCLUSIONS

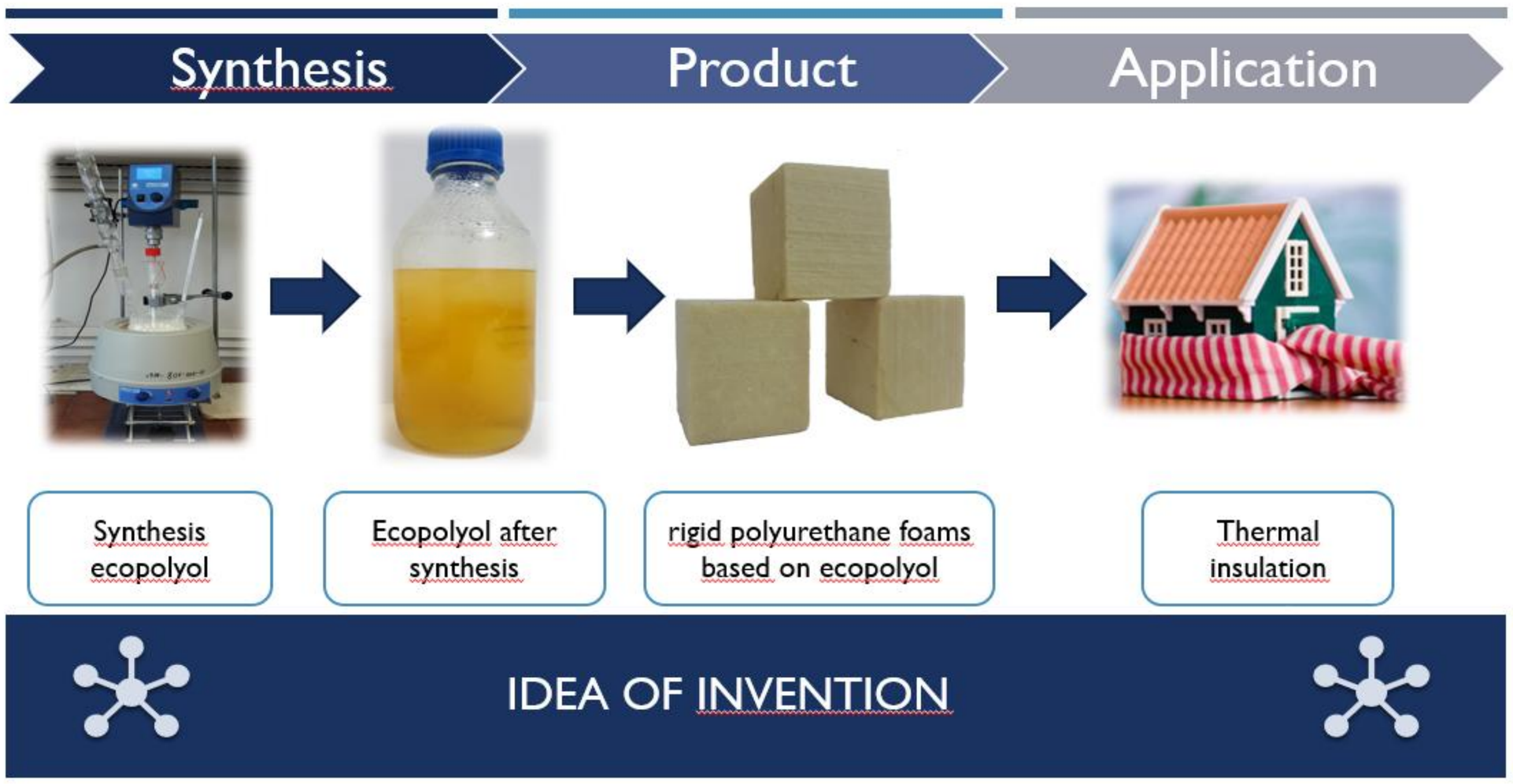
-The presented method of managing polylactide waste is a simple technology that allows for the "extension of the life cycle" of polylactide that has fallen into disuse, which is fully consistent with the principle of sustainable development and a circular economy.

-The presented method allows the transformation of polylactide waste into full-value polyol products, which were used to synthesize rigid polyurethane foams.

-The eco-polyols obtained from waste polylactide allow for partial elimination of the petrochemical polyol used to obtain rigid polyurethane foams, without impairing their functional properties.

-The presented technology solves the current problems of the polyurethane industry, which is striving to eliminate petrochemical polyols in favor of recycled polyols (eco-polyols).

OBJECTIVES



REFERENCES

Marcin Borowicz, Marek Isbrandt, Joanna Paciorek-Sadowska, Effect of New Eco-Polyols Based on PLA Waste on the Basic Properties of Rigid Polyurethane and Polyurethane/Polyisocyanurate Foams. International Journal of Molecular Sciences, 2021, 22 (16), 8981.

CONTACT

Joanna Paciorek – Sadowska e-mail: sadowska@ukw.edu.pl
Marcin Borowicz e-mail: m.borowicz@ukw.edu.pl
Marek Isbrandt e-mail m.isbrandt@ukw.edu.pl

University of Kalisz

The project is co-financed from the state budget,

allocated by the Minister of Science under „Doskonała Nauka II" programme.

Ministerstwo Nauki i Szkolnictwa Wyższego