Durable bio-based polymer composites reinforced with natural waste fillers with antibacterial properties (EcoMat) M-ERA.NET Call 2021,
M-ERA.NET3/2021/79 EcoMat/2022

Stanisław Kuciel[1], Maria Kurańska[1], Karina Rusin-Żurek[1], Patrycja Bazan[1], Szymon Gądek[1]
Karolina Mazur[2], Rafał Nowak[2]
Andrey Aniskevich[3] , Olga Bulderberga[3], Solvita Kristone[3], Sergejs Tarasovs[3]
[1]**Cracow University of Technology**, Faculty of Materials Engineering and Physics, Warszawska 24, 31-155 Kraków, Poland
[2] **RANPLAST Sp. z o.o**. 32-020 Wieliczka, Śledziejowice 222, Poland
[3] **University of Latvia**, Institute of Polymer Mechanics, 23 Aizkraukles St., LV-1006, Riga, Latvia

Abstract

Alarming information on environmental pollution prompted the scientific community and industry to search for sustainable solutions aimed at reducing the negative impact of manufactured products on the environment. Therefore, the project aimed to create a functional, ecological polymer composite based on bio-based PET reinforced with natural waste particles (coffee grounds, eggs, and mollusks shells) with antibacterial properties.

The main goal of the project was to develop a functional hybrid ecological thermoplastic composite with antibacterial properties.The base material was a bio-based matrix – polyethylene terephthalate (bioPET), while waste particles were used as the reinforcing phase: coffee grounds, chicken eggshells, and mollusk shells.
Moreover, the composites were modified with antibacterial particles – traditional metals and their oxides: silver, copper oxide and titanium oxide.

To achieve this goal, secondary objectives were defined, which aimed at creating a universal method of modification of waste particles.
All produced composites were subjected to mechanical testing – tensile, bending, and impact tests, as well as low- and high-cycle fatigue tests. SEM images were also taken to assess the surface structure and the adhesion between the fillers and the polymer matrix. The organic particles were analyzed for size, and their structure was examined using an optical microscope. Some of the composites were also tested for wettability, and the total free surface energy was determined.
As a result of the project, universal chemical modifications of fillers were proposed in order to increase the adhesion of the fiber/matrix, which positively affected the strength properties. Moreover, a universal mathematical model was developed, the task of which was to predict the properties of polymeric materials and the life expectancy of the manufactured materials. The produced materials could be successfully used in many industrial sectors, both for products with a short and long life cycle. The project proposed a universal stand for small electronic equipment. The product was characterized by high mechanical properties as well as antibacterial properties that were so important at the time.

Acknowledgements: Authors would like to thank the M-ERA.NET Call 2021, M-ERA.NET3/2021/79 EcoMat/2022 Durable bio-based polymer composites reinforced with natural waste fillers with antibacterial properties