# PET – A Problem on a Global Scale

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**We deal with plastics every day, since the possibilities of their application are very broad. We surround ourselves with these substances at home or in our workplaces; they are used in many industries, but also in everyday life. Versatility and ease of use are their main properties. Currently, the challenge is the possibility to use materials multiple times – that is, to subject them to recycling. Researchers from the Institute of Chemistry at the University of Silesia in Katowice are investigating these possibilities as part of the project titled *Methodology of continued synthesis of 1,3-dioxolanes along with the extension of the range of applicability of target products in the chemical industry*, led by Dr. Maciej Kapkowski.**

The abbreviation PET is generally recognizable, but few people know what hides behind this acronym and concept. PET is a polymer which is popular on a global scale, used for plastic packaging and primarily associated with bottles for all kinds of beverages. Polyethylene terephthalate, since this is its name, is a thermoplastic polymer with high mechanical strength, belonging to the group of polyesters. It has insulating properties and a good chemical resistance to weak acids, oils, fats, and alkali solutions. In addition, it can be quite easily heat treated. It is characterized by high abrasion resistance, and most importantly, it is recyclable. Polyethylene terephthalate waste has the highest recycling rate of all plastics, yet much of it accumulates in ecosystems, posing a significant environmental problem and therefore conservation, Dr. Eng. Mateusz Korzec remarks.

Why is this the case? The source of a large amount of waste is PET packagings for storing and transporting food. These packages are quickly "consumable" i.e. their shelf life expires when the food in which they were stored or secured has been consumed. This happens, for example, after drinking water – the bottle becomes waste for recycling. Unfortunately, most recycled PET (rPET) is not approved for contact with food. This is due to the possibility that plasticizers, hardeners, or other chemicals from various recycling steps will be present in them. Contact of these contaminants with food can be a health hazard, and therefore the issue of rPET reuse in food packaging is approached with great caution. The companies that recycle PET for food contact have to meet stringent requirements, undergo appropriate procedures, and prove that their PET recycling method results in producing a material of the highest safety standard. The European Food Safety Agency (European Food Safety Agency), an institution responsible for the quality control of the obtained rPET, reviews the possibility of allowing a given recycling method for the production of packaging in contact with food in Europe. Currently, technologies are being developed to obtain rPET for the production of mineral water bottles in amounts not exceeding 70% of recycled PET. Research on obtaining the appropriate quality of rPET intended for contact with food is still being conducted, therefore, in the near future, recycled PET packagings will be used to a greater extent. PET waste is generated continuously and over short periods. Moreover, the possibilities of reusing it are still insufficient to fully manage rPET. This is a problem on a global scale. Therefore, research on the development of effective, ecological, and at the same time economically viable methods of PET recycling is being carried out. The essential goal is to obtain high purity material and increase the amount of

recycled material. Currently, work on new ways to apply the available rPET in other fields is also underway. It should also be borne in mind that recycling the same material several times may carry the risk of producing materials with increasingly worse quality parameters.

The recycling process is handled by specialized companies that predominantly obtain the original PET waste from industrial and municipal waste management companies. Waste separation is also an important issue. The waste is dealt with in sorting plants, where raw materials for recycling are recovered to some extent. Specialized companies subject PET materials to a complex process of treatment and processing, and thus become the main supplier of a wide range of polyester recyclates in the form of granules, powder, chips, or flakes. Subsequently, the recycled raw materials (polyester recyclates) can be used to produce e.g. polyester fibers, new packaging (mainly for chemicals), or polyester resins. Recycled PET can also be used in civil engineering projects, e.g. road construction, modification of asphalt, cement, or concrete – that is, in the production of broadly understood building materials. The addition of polymer allows to improve their selected physico-chemical parameters and to reduce the production of other plastics (used as additives). This is fully justified in terms of economy and environmental protection. Another use of rPET could be the production of filament for printing plastic materials (to replace filament made from polycarbonate-ABS). The interest in recycled materials (rPET) is relatively high, a circumstance related to the availability of this material in almost "unlimited" amounts and the need to protect the environment due to its low biodegradability.

What else can be done?
"The main three directions related to PET recycling are to conduct research in the development of efficient recycling methods, to increase the amount of global PET recycling, and to inquire into new uses for polyester recyclates," explains Dr. Eng. Sonia Kotowicz. "These directions are important from the point of view of economic, ecological, and rational management of the raw material. The inability to discard this material as well as the growing problem with its quantity, necessitates changes in the reuse and wider use of rPET for packaging intended for contact with food."

As part of the LIDER grant, financed by the Polish National Center for Research and Development, research is being conducted at the University of Silesia on the possibility of using rPET in organic electronics and in other fields. Research focuses on the area where the "time of use" will be relatively long, which will certainly contribute to a partial solution to the problem of the material's reuse for the benefit of human health and the environment. The solution being investigated is the use of rPET in photovoltaics. The most important part of the research is conducted by Dr. Mateusz Korc, a specialist in the recycling of materials, organic synthesis, and the fabrication of active layers for photovoltaic panels. Dr. Eng. Sonia Kotowicz deals with research on and characterization of active layers in photovoltaic panels, while Dr. Karina Kocot finalizes the activities, i.e. performs qualitative and quantitative analyses of nanomaterials as well as instrumental purity analyses of reaction products. The efforts of these young scientists could bring significant progress in partially solving the rPET problem, while opening up opportunities for further research.

**PET bottles are subjected to the process of shredding and purification, which allows to obtain PET flakes that can be further processed into a film, obtaining substrates made of rPET (i.e. recycled PET) / Photo: Sonia Kotowicz**