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Editorial corner – a personal view

Recycling issues with multilayer packaging

Csenge Tóth[1], *Ábris Dávid Virág*[1], *László Mészáros*[1,2*]

[1]Department of Polymer Engineering, Faculty of Mechanical Engineering, Budapest University of Technology and Economics, Műegyetem rkp. 3., H-1111, Budapest, Hungary
[2]HUN-REN–BME Research Group for Composite Science and Technology, Műegyetem rkp. 3., H-1111 Budapest, Hungary

Multilayer packaging, commonly referred to as a beverage carton, is a widespread packaging solution that combines the beneficial properties of different materials to achieve the desired function. Beverage cartons contain paper, polyethylene (PE), and aluminium (Al), a combination that can protect sensitive foods and liquids, ensuring a longer shelf life. However, their complex composition makes their recycling challenging. Although paper, aluminium, and plastic can be recycled many times, beverage cartons are often incinerated or landfilled because separating the components is technologically challenging and not economically rewarding (https://doi.org/10.3390/recycling3010001).

Meanwhile, the world is moving towards sustainability and a circular economy, which has increased the demand for recycled materials (https://doi.org/10.3144/expresspolymlett.2023.88). Among the waste collected separately, the recyclable fractions stand out as the most lucrative revenue opportunity for those selling them (http://dx.doi.org/10.1007/698_2017_24). Therefore, there is a strong need for solutions to separate beverage cartons into their constituent parts on an industrial scale. A widely used solution is the so-called hydro-pulping, which allows the softened paper to be separated and recycled. Hydro-pulping generates large amounts of wastewater, so the possible use of less environmentally damaging, reusable solvents is also been researched extensively (https://doi.org/10.1016/j.resconrec.2023.107367, https://doi.org/10.1016/ j.resconrec.2022.106444). Separating PE and Al is even more challenging. There are various solutions based on the chemical dissolution of PE (http://dx.doi.org/10.1016/j.wasman.2014.10.008) or pyrolysis (https://doi.org/10.1016/j.wasman. 2021.11. 007, https://doi.org/10.1016/j.wasman.2013.01.031), but these are energy-intensive, costly and have a significant environmental impact. Therefore, PE/Al is most often not separated but used as a composite since it is suitable for injection molding low-demand plastic products (https://doi.org/10.1016/j.compositesb.2012.10.019). Beverage cartons can also be recycled as shredded material, for example as the core of lightweight composites (https://doi.org/10.1016/j.compstruct.2022.116380), but this makes future waste management even more difficult.

The materials of the future are multifunctional, adapting to complex needs but with a low specific weight. Thus, developing composite materials is a prominent research direction in materials science, with outstanding results in high-performance fiber-reinforced composites or multilayer packaging with oxygen and aroma barrier properties. However, to become the materials of the sustainable future, they have to be integrated into the circular economy. Combining materials with different properties is difficult, but separating them is even more challenging. We anticipate that the future will likely bring the development of new, alternative recycling techniques that solve the problem of separating multi-component materials without significantly degrading the properties of the components, thus creating recyclable fractions.

*Corresponding author, e-mail: meszaros@pt.bme.hu