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*Editorial corner – a personal view*

# Development challenge for synthetic polymer fibers and tapes: improving toughness

*László József Varga*[1], *Tamás Bárány*[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]MTA-BME Lendület Lightweight Polymer Composites Research Group, Műegyetem rkp. 3., H-1111 Budapest, Hungary

Polymer fibers are essential in the textile industry, as they can provide various properties such as strength, durability, elasticity, and resistance to heat, chemicals and abrasion. Synthetic polymer fibers can also be a sustainable way to produce clothes in large numbers, as they do not require a large land area and resources to breed the animals and to grow the plants that natural fibers are originally acquired from. Synthetic polymer fibers and tapes are also used in various industrial segments, such as aerospace, automotive, construction, medical, and packaging, including the strongest possible fibers and tapes, such as aramid and ultra-high molecular weight polyethylene (UHMWPE) fibers, and industrial fibers, such as nylon, polyester, polypropylene, and polyethylene fibers, which can offer good mechanical properties, low cost, and are easy to process.

Molecular orientation is one of the vital factors of the excellent performance of polymer fibers and tapes. Molecular orientation is usually achieved in the liquid state (polymer melt or solution), or by solid-state drawing, which involves stretching the polymer melt or solid polymer at a specific temperature and speed or by their combined application. Molecular orientation drastically increases the tensile strength and modulus of the polymer fibers and tapes.

However, molecular orientation reduces the strain at break of the polymer fibers and tapes, making them less tough and prone to fracture. Therefore, one of the most important challenges in developing these products is to increase their toughness and resistance to crack propagation while retaining their tensile strength and modulus.

One way to improve the toughness of polymer fibers and tapes is to use additives that can modify the structure or interactions of the polymer chains. For example, nano-size additives, such as carbon nanotubes (https://doi.org/10.3390/polym14020260) or montmorillonite (https://doi.org/10.1080/20550324.2019.1671038), can be incorporated into the polymer matrix to enhance its mechanical properties.

Blending is also a possible way to improve the toughness of the tapes. Some polymers can facilitate the movement of the molecules of the tape during the drawing process and, in some cases, even afterward; thus, blending can improve the toughness of the drawn tapes. In the case of polypropylene (PP) tapes, amorphous poly-alpha-olefins (APAOs) had this effect on drawn, highly oriented tapes (https://doi.org/10.1021/acsomega.3c01772).

The sustainability of production can be increased by using biodegradable polymers, which can degrade under certain industrial conditions. For example, poly(lactic acid) (PLA) is a polyester that can be derived from renewable sources such as corn starch or sugar cane (https://doi.org/10.3390/fib3040523) and can be composted. The molecular orientation of PLA is a heavily researched area, but PLA still has some limitations, such as low thermal stability and poor hydrolytic resistance. Therefore, optimizing PLA for industrial applications requires a lot of research.

The production of polymer fibers and tapes has a long history, but with new materials and additives, there is still room for improvement. Polymer fibers and tapes will continue to play a vital role in various fields that require high performance and sustainability.

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