Which Polyester Is It? Applying pyrolysis-GC/MS to identify commercial polyesters and standardize microplastics reporting

Josh Forakis*[1] and Jennifer Lynch†[1,2]

[1]Hawaii Pacific University (HPU) – 41-202 Kalanianaole Highway, Waimanalo, Hawaii 96795, United States

[2]National Institute of Standards and Technology [Waimanalo] (NIST) – 41-202 Kalanianaole Highway, Waimanalo, Hawaii 96795, United States

Abstract

Microplastic fibers, defined as synthetic polymer fibers between 1 μm and 5 mm in length, are a significant source of microplastic pollution. Consumer products such as stuffed toys, bedding, carpets, curtains, and clothing are often made of material labeled "100% polyester fibers." The specific chemical composition of polyester fibers is often proprietary and mostly assumed to be poly(ethylene terephthalate) (PET) (i.e., #1 resin code plastics). However, polyesters encompass a range of compounds, including other synthetic aromatic polymers like poly(butylene terephthalate) (PBT), poly(cyclohexylenedimethylene terephthalate) (PCT), and poly(ethylene naphthalate) (PEN), as well as biodegradable polymers. The blanket term "polyester" refers to multiple polymer identities, which causes challenges for the plastic pollution research community who relies on accurate spectral libraries to correctly identify and report environmental plastics.

Our study aimed to clarify whether consumer polyester products consist primarily of PET or a variety of polyester compounds. We analyzed several scientific-grade polyester reference standards, 50 manufacturer-grade polyester fibers, and fibers from over 200 consumer polyester products using pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS). Consumer and manufacturer samples labeled "polyester" were predominantly identified as PET (n = 227). Furthermore, the study identified five samples as a type of polyester other than PET (e.g. PBT, PCT, PEN), nine samples as non-polyester polymers (e.g., PAN, PVC, cotton, and PP), and 23 samples as a blend of PET with another polyester. Our results imply that the general term polyester actually refers to multiple polymer types. We suggest that specific polymers (e.g., PET, PCT, PBT), when known, be included in spectral libraries, rather than the generic term polyester. These findings will be discussed regarding how they contribute to tracking sources, evaluating impacts, and reusing microplastics found in the natural environment.

Keywords: Microfibers, polyester, consumer goods, py, GC/MS, analytical methods, polymer identification

*Speaker

†Corresponding author: jennifer.lynch@nist.gov