Recycling Neolast: A Sustainable Spandex Alternative

Claire Sklar, Peter Lim, Aryan Anand, Laurice Djepeno

Johns Hopkins Whiting School of Engineering

Design Challenge

In collaboration with Celanese, Under Armour has developed a high-performing elastic alternative to spandex: **Neolast**. With a green, **solvent-free manufacturing** process, Neolast shows promise in addressing the textile industry's challenge of **achieving the stretch of spandex without the environmental harm.**

Stretchy textiles also cause environmental harm in their disposal: they are difficult to shred and recycle, so they accumulate in landfills. Recovering and recycling Neolast from composite textiles would minimize textile waste, further contributing to Under Armour's sustainability goals.

Under Armour needs a process to separate Neolast from polyester in composite textiles to recycle the fibers.

Defining NEOLAST™

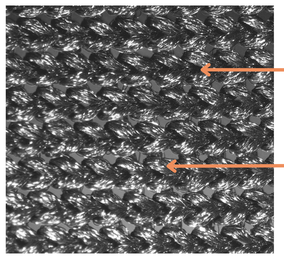


Fig. 1: Optical Microscope Image of Composite Textile (20% Neolast, 80% Polyester)

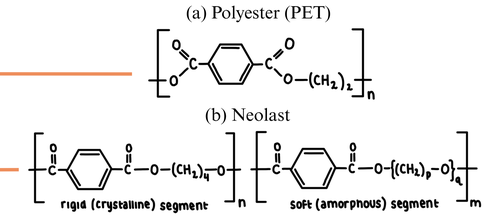


Fig. 2: (a) Polyester chemical structure, rigid polyethylene terephthalate linked by ester bonds **(b)** Neolast chemical structure, thermoplastic, alternating polybutylene terephthalate (rigid) and long chain polyol (soft) segments linked by ester bonds

What is FTIR?

FTIR passes infrared radiation through the chemical bonds within a molecule to measure their vibration, allowing us to **characterize the molecule's chemical structure**. Strong peaks represent unique aspects – for example, the peak at 1700 cm^{-1} represents ester bonds and the peak at 2900 cm^{-1} indicates the Neolast soft segments.

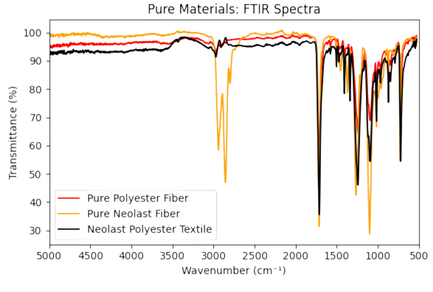
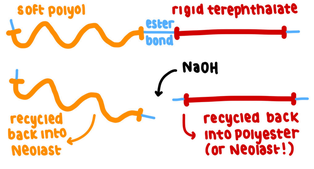
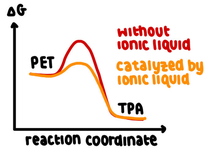


Fig. 3: FTIR spectra of pure polyester fiber, pure Neolast fiber, and composite Neolast polyester textile

Theory of Alkaline Hydrolysis



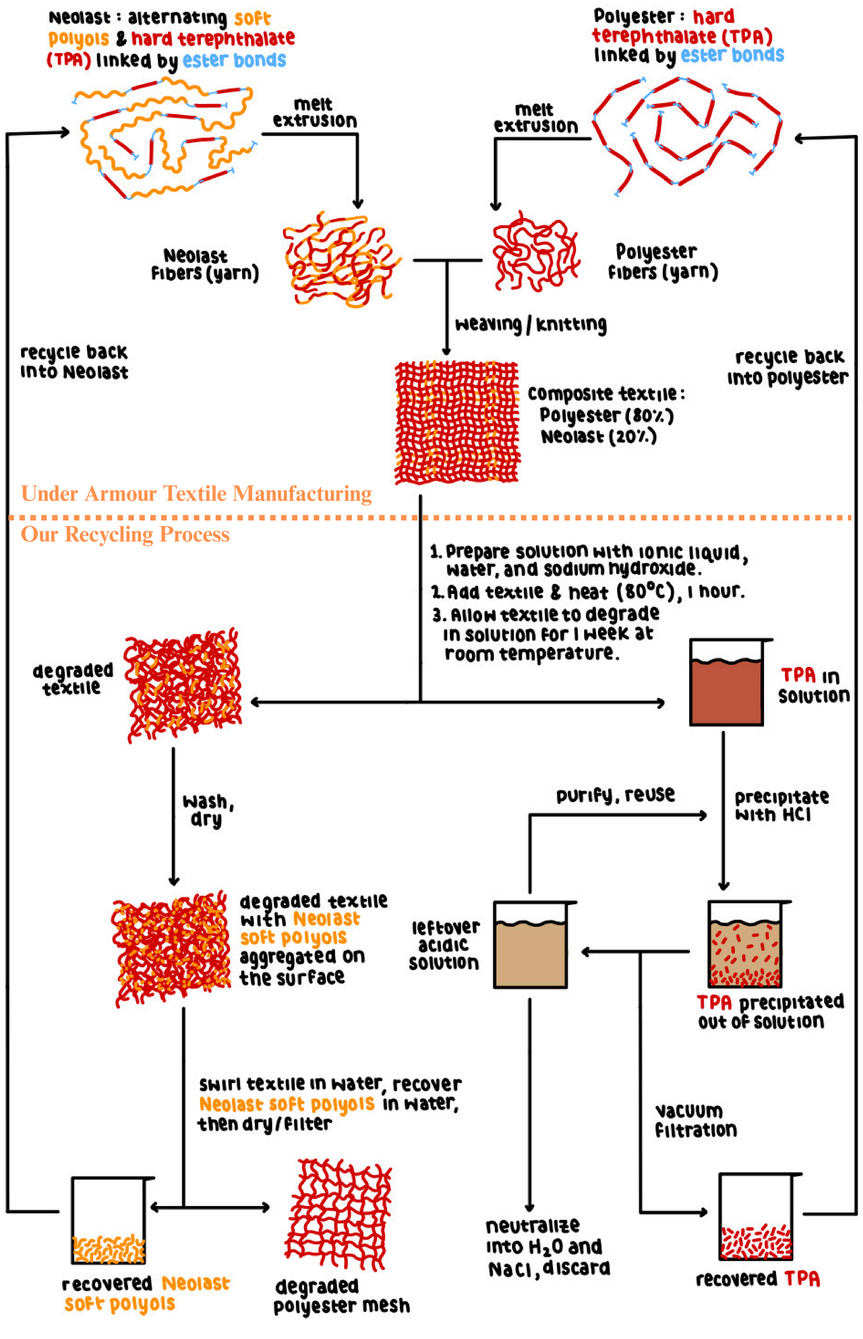
Role of Ionic Liquids



Ionic liquids consist entirely of ions and are liquid at room temperature!

With a sufficient carbon chain length, ionic liquids can become cationic surfactants – they lower the surface tension of water to catalyse the reaction. They are also more sustainable (less volatile) than the traditionally used methanol.

Solution: Alkaline Hydrolysis Based Recovery of Neolast Soft Segments



FTIR Data Analysis

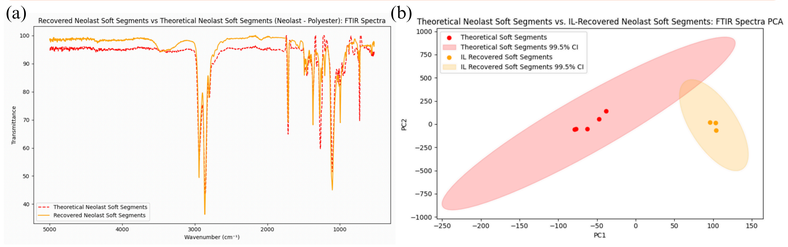


Fig. 5: FTIR Analysis of Recovered Neolast
Theoretical Neolast Soft Segments spectrum was generated by subtracting the pure polyester spectrum from the pure Neolast spectrum and normalizing.
(a) Overlay of transmittance spectrum for theoretical and recovered Neolast soft segments
(b) PCA (Principal Component Analysis) for theoretical and recovered Neolast soft segments, an overlap is observed within 99.5% confidence ellipses

Environmental Analysis

Fig. 6: Energy Usage and CO2 Emissions of Virgin PET and Recovered PET

In addition to having **nearly equal energy cost** and **reduced CO2 emissions**, recovered PET via alkaline hydrolysis also has the additional benefit of recovering Neolast. Furthermore, alkaline hydrolysis is **separation independent**, meaning textile made of PET and Neolast does not need to be pre-separated (unlike most other recycling processes for PET).

Scalability

Acknowledgments: Special thanks to Matt Trexler and Under Armour for supporting this project!