

Design and Prototyping of a Lunar-Compatible Nomex-Nylon Recycling System for Additive Manufacturing

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Problem

Long-duration lunar missions generate recurring polymer waste streams, including Nomex cargo bags and multilayer nylon food pouches. Under current architectures, this material must be stored or returned to Earth, increasing launch mass and logistics burden. Existing recycling methods do not address multimaterial separation or validate mechanical performance after reprocessing. A closed-loop, in-situ polymer recovery system is required to enable sustainable lunar surface operations.



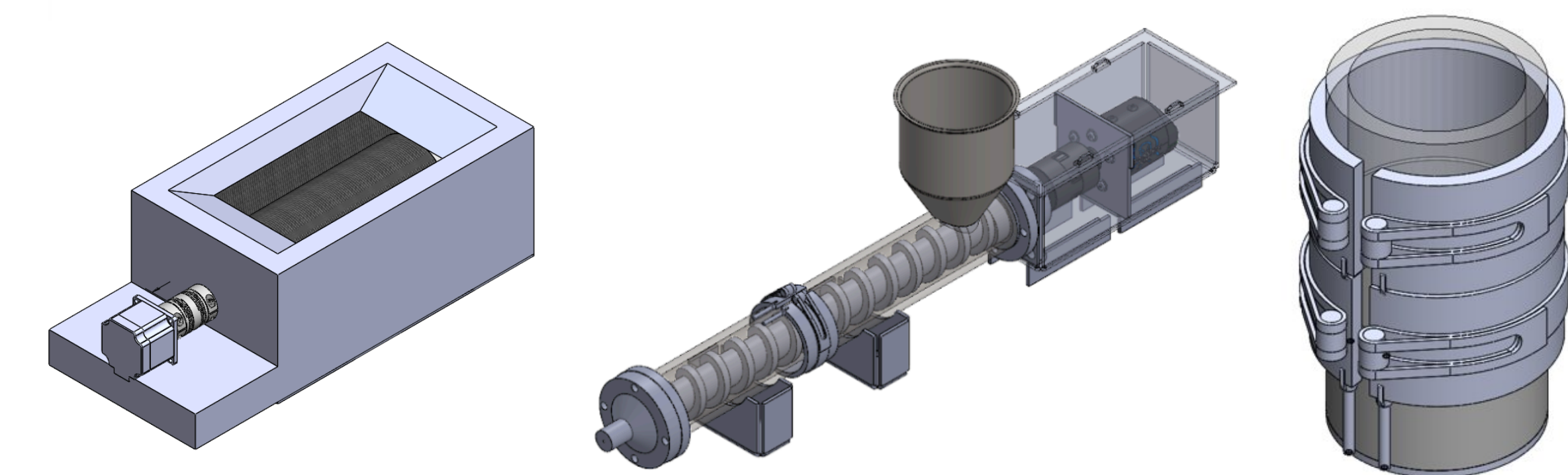
Project Requirements

- Material Processing
 - Shred Nomex bag material and Rehydrateable pouches
 - Separate Nylon from Rehydrateable pouches using thermal filtration
 - Minimal Crew time Requirements (<45 minutes)
- Extrusion of a polymer filament combining Nylon and Nomex material

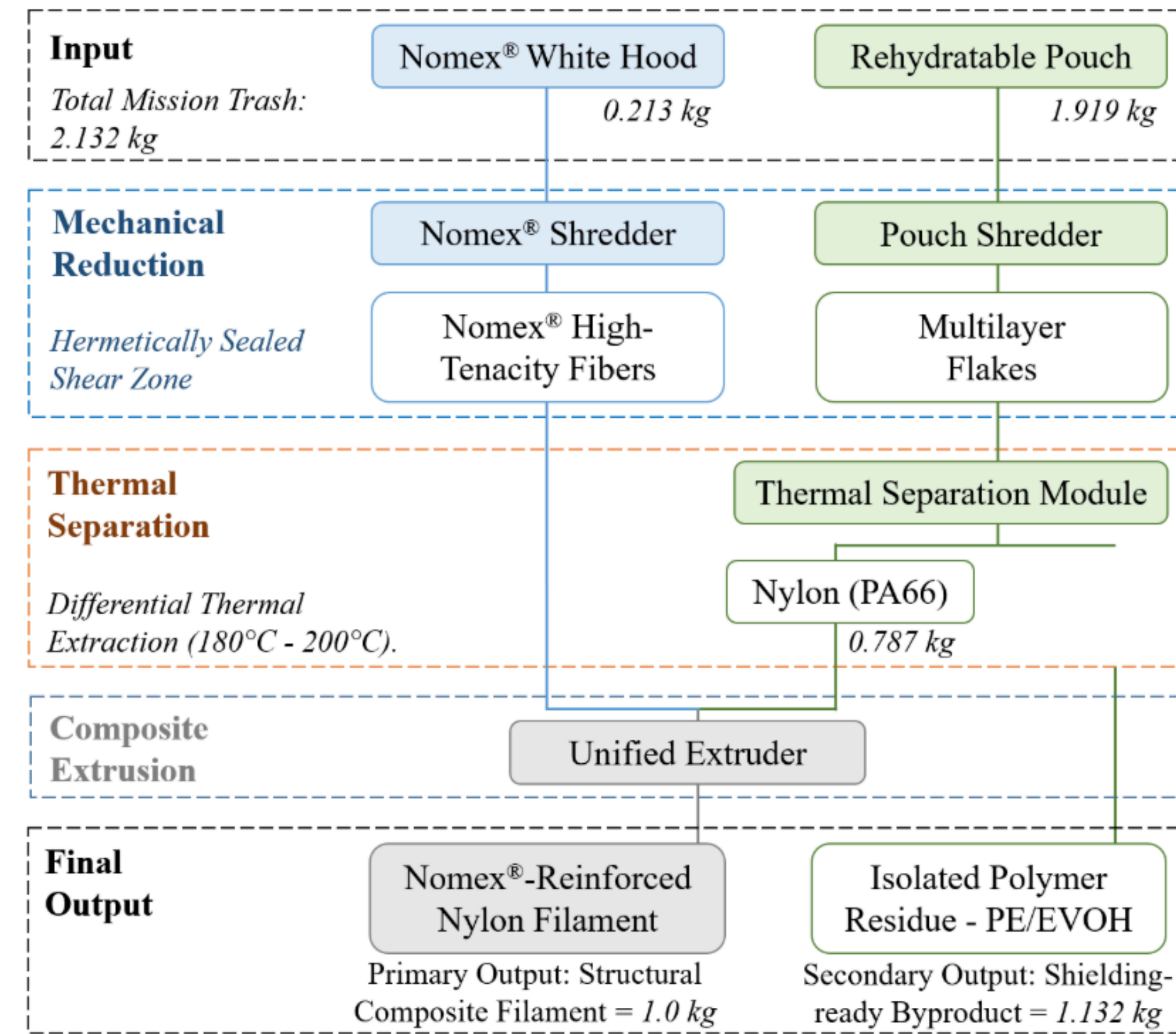
Design Overview

- Two Shredders one for each recycled material
- Thermal Separation Module for melt filtration to extract Nylon
- Filament Extruder that combines and extrudes a composite polymer filament of Nomex fibers and Nylon
- All systems controlled and operated via Raspberry Pi interface

Shredder Filament Extruder Melt Filtration

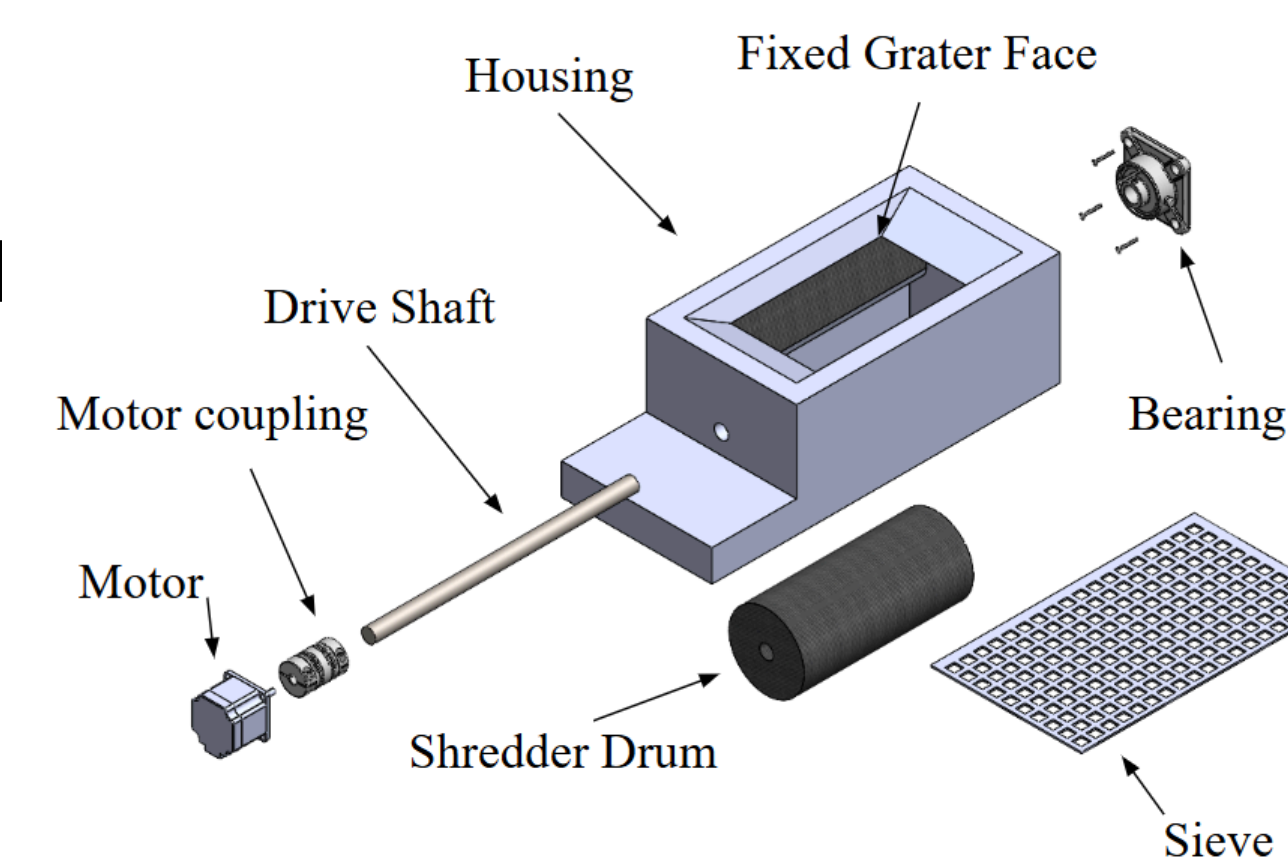


Methodology



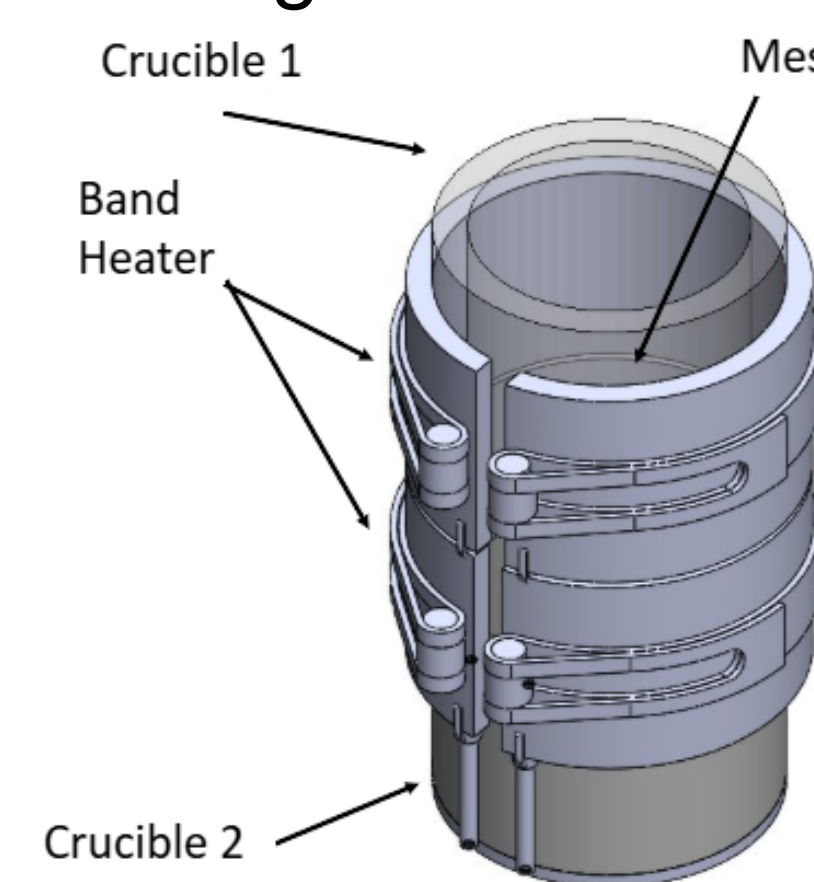
Material Reduction (Shredding)

Mixed Nomex cargo bags and nylon pouches are mechanically reduced to controlled particle sizes to enable uniform thermal processing.



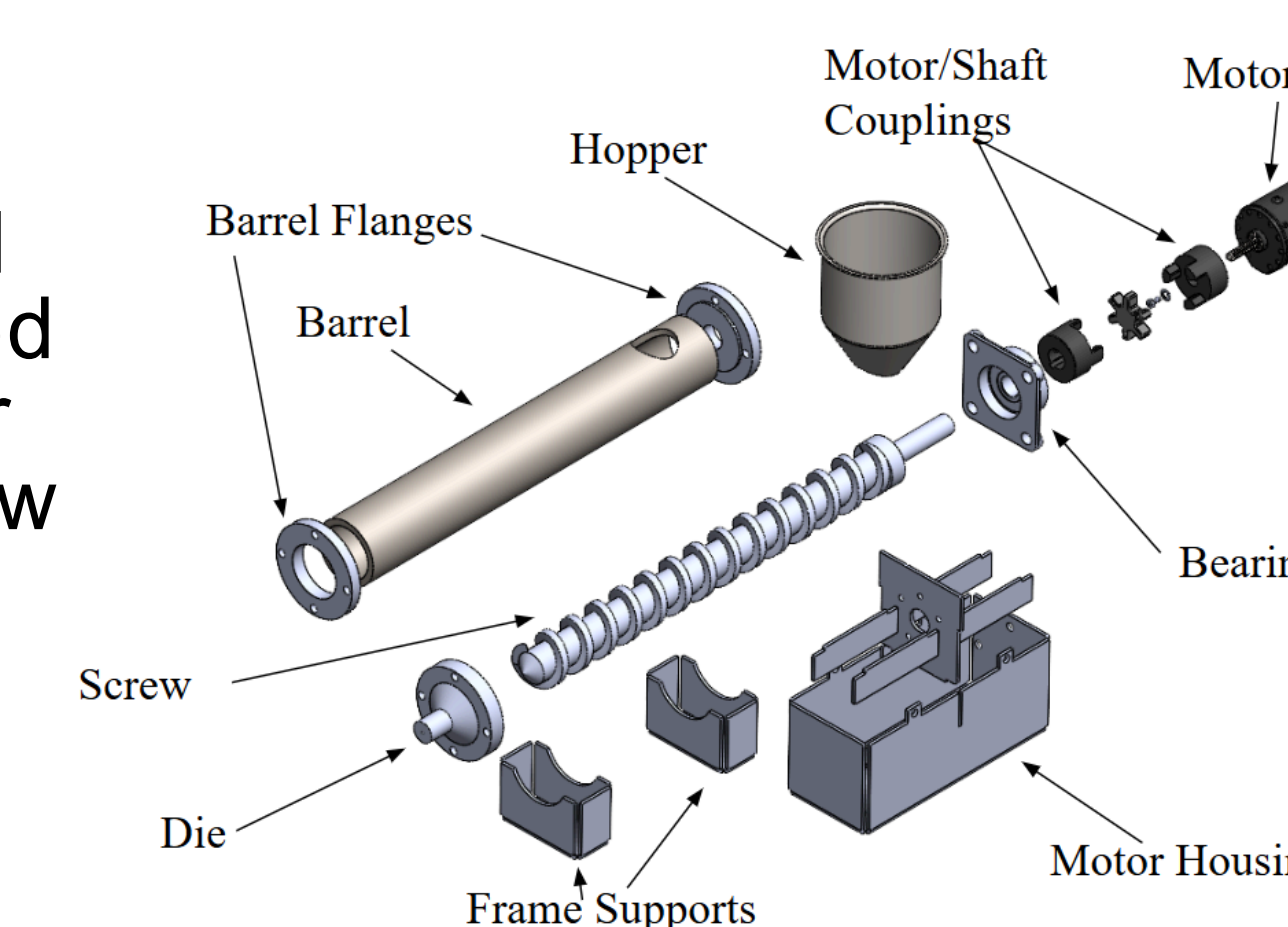
Melt Filtration

A heating system operating within a defined thermal window to selectively melt and recover nylon from shredder pouch material.



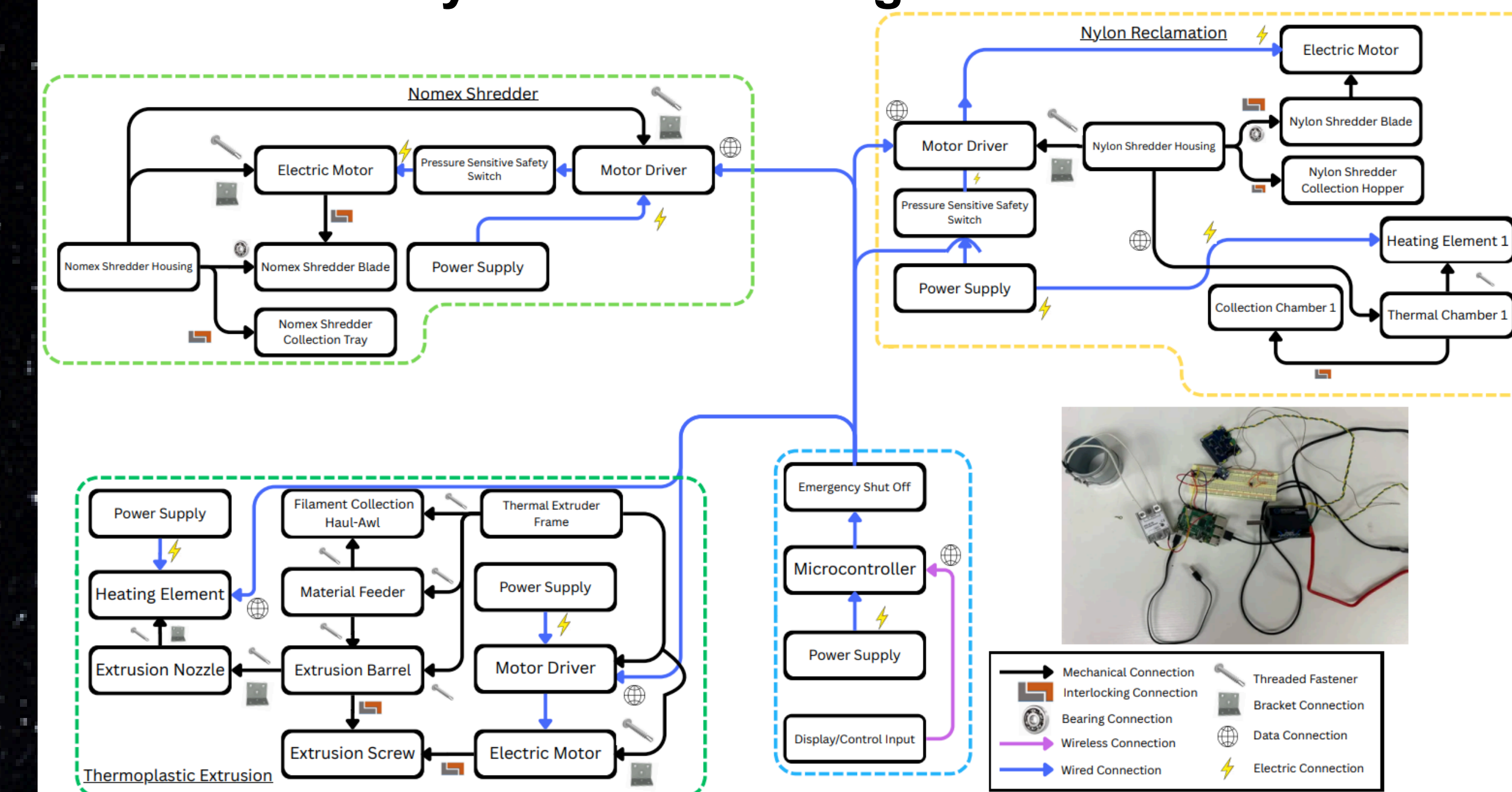
Filament Extrusion

Recovered nylon melt is mixed with Nomex fibers and extruded into FDM-grade filament under controlled temperature and flow conditions to achieve dimensional stability.



Electronics & Validation Framework

Electronic System Level Diagram



Validation

- Tensile testing per ASTM D638
- Melt flow rate evaluation per ASTM D1238
- Thermal stability characterization via DSC/TGA (ASTM D3418 / E1131)
- Filament dimensional monitoring

Meet The Team!



Acknowledgments

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