Northwestern | QUERREY INQBATION LAB **2025 SUMMER SCHOLARS PROJECTS**

PROJECT CATEGORY: CleanTech

STARTUP: NylaNova Inc.

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RESEARCH AREA: Driven by an urgent call to reduce plastic pollution, NylaNova aims to revolutionize recycling using the power of chemistry. NylaNova is a pioneering startup dedicated to transforming the recycling of Nylon-6. Our proprietary solvent-free chemical recycling technology recovers high-purity caprolactam, the monomer of Nylon-6, from mixed plastic streams currently deemed non-recyclable. This recovered caprolactam is seamlessly repurposed to produce virgin-quality Nylon-6, effectively closing the loop and enabling true circularity in the nylon lifecycle.

PROJECT TITLE: Understanding the Impact of Volatile Dyes and Additives in Post-Consumer Nylon-6 Containing Textiles on the NylaNova Chemical Recycling Process of Nylon 6.

PROJECT DESCRIPTION

The intern will play a key role in NylaNova's efforts to optimize its chemical recycling process by addressing one of the most critical challenges: understanding and mitigating impurities in post-consumer Nylon-6 containing textiles. Most Nylon-6 containing textiles (clothes and carpets) contain dyes, finishes, and additives that can volatilize during the recycling process. Since NylaNova's process operates under vacuum and at high temperatures, it is essential to identify which impurities transfer to the recycled caprolactam and which remain compatible with the process. This aligns with key requirements from NylaNova's joint development agreement partner and is pivotal for the scalability and success of our technology.\

The project involves:

1. Sample Analysis: Collecting and analyzing volatile fractions from at least 8 colored fabric samples. These samples will be melted under vacuum to identify and quantify dyes and additives using advanced analytical techniques such as NMR, GC-MS, and other relevant tools. Following this, the presence of specific volatile impurities will be tested in one of the fabrics after it has been run through NylaNova's depolymerization process. This will help determine whether these volatile impurities carry over into the recovered caprolactam.

2. Classification: Differentiating between volatile additives (which often volatilize during processing and create challenges such as contamination or reactor fouling) and non-volatile additives (which remain stable and are compatible with the depolymerization of Nylon-6 fabrics).

3. Optimization: Developing and testing methods to remove undesirable volatile impurities by optimizing conditions (temperature, time) for vacuum processing or through solvent extraction techniques.

4. Validation: Testing untreated and optimized materials in NylaNova's depolymerization reactor to assess the purity of the resulting caprolactam and validate improvements. This part will be conducted by one of NylaNova's employees.

This work is crucial for ensuring uninterrupted reactor operations and maintaining the high purity of recycled caprolactam.

JOB EXPECTATIONS:

The expected outcomes for the project include:

1. Testing at least 8 colored fabric samples sourced from industrial partners to analyze their dyes and additives.

2. Quantifying these dyes and additives' weight %, molecular structures, and properties.

3. Categorizing additives into "compatible" (non-volatile) and "volatile" (those that volatilize and might disrupt recycling) based on their behavior during the melting process, where volatile compounds are collected under the high-temperature and vacuum conditions of NylaNova's recycling method.

4. Establishing optimal processing parameters, including temperature and time, to effectively remove volatile impurities through vacuum or solvent-based methods.

5. Developing and validating a pre-treatment strategy for waste fabrics to enhance the purity of caprolactam recovered during the depolymerization process by testing untreated and pre-treated post-consumer Nylon-6. Comparative analysis of reactor outputs will provide measurable data on the impact of pre-treatment on caprolactam purity and process efficiency, focusing on the removal of additives and dyes that may disrupt the recycling process.

Deliverables include a detailed report of findings, experimental conditions, and validated optimization protocols.

DESIRED EXPERIENCE:

- Strong analytical background, particularly in NMR, GC-MS, and UV-VIS.
- Ability to independently review scientific literature.
- Hands-on experience in experimental lab work.

TIME COMMITMENT:

8 weeks

TRAINING MENTORING:

This internship provides an exceptional opportunity to contribute to a breakthrough in sustainable plastic recycling while gaining hands-on experience with cutting-edge industrial techniques. The work has direct implications for the scalability of NylaNova's technology and the future of circular materials.