BUTTERFLIES Project

Bio-Polymers & Additive Manufacturing

Newsletter II

Advancements in Chitin-Based Bio-polymers for BJT and 2PP Technologies

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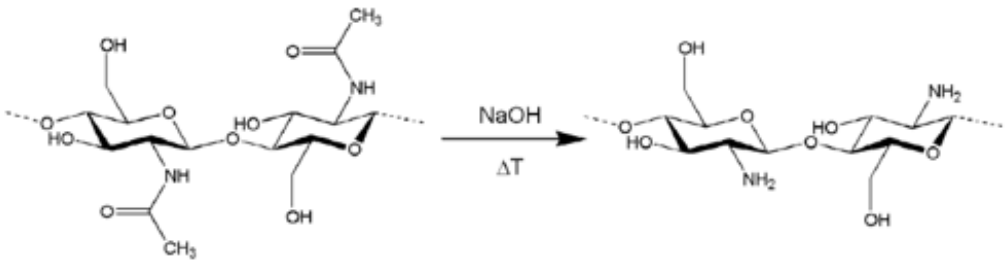
Advancements in Chitin-Based Biopolymers for BJT and 2PP Technologies

As part of the **BUTTERFLIES project**, we are advancing the optimization of chitin-based derivatives to redefine the sustainability of additive manufacturing. The primary goal is to develop high-performance, bio-intelligent binders for two distinct 3D printing technologies: **Binder Jetting (BJT)** and **Two-Photon Polymerisation (2PP)**. By replacing synthetic chemicals with renewable biopolymers, the aim is to enhance material strength and biocompatibility while significantly reducing the environmental footprint of the manufacturing process.

Core Materials: The Versatility of Chitin and Chitosan

The research focuses on two primary biopolymers sourced from renewable materials:

- **Chitin:** An abundant, biodegradable, and antimicrobial polymer. Due to its high crystallinity and hydrogen-bonding network, it provides exceptional structural reinforcement, although its inherent insolubility requires advanced processing to be utilized as a functional binder component.
- **Chitosan:** The deacetylated derivative of chitin. The conversion of N-acetyl groups into amine groups increases the polymer's polarity and solubility in acidic media. This makes chitosan an ideal candidate for biomedical applications, offering superior biocompatibility and the ability to be chemically modified.



Chitin Chitosan

Advanced Production Pathways: Balancing Efficiency and Green Chemistry

BUTTERFLIES project is employing a hybrid approach that combines traditional chemical methods with innovative "green" solvents to obtain primary binder components.

Chitin Nanocrystals (ChNC)

Using "top-down" strategies to isolate nanocrystals:

- **Acid Hydrolysis:** Controlled degradation using sulfuric or hydrochloric acid. By precisely tuning acid concentration, temperature, and reaction time, nanocrystals of optimal size and quality can be isolated.
- **NADES (Natural Deep Eutectic Solvents):** As a sustainable alternative, NADES are being implemented to disrupt the chitin hydrogen bond network. This reduces the reliance on harsh acids and facilitates a more eco-friendly modification process.

Chitosan

The conversion of chitin into chitosan is optimized through two main routes:

- **Alkaline Treatment:** Traditional high-temperature processing using concentrated sodium hydroxide (NaOH) to reach the desired degree of deacetylation.
- **NADES-assisted Deacetylation:** A novel approach where NADES systems are used to facilitate the attack on N-acetyl groups. This allows the deacetylation reaction to occur efficiently with significantly lower concentrations of NaOH, aligning the project with green chemistry principles.

Characterization

To ensure that the produced materials meet the functional requirements for 3D printing, a comprehensive analysis is being carried out:

- **Morphological & Structural Analysis:** SEM (Scanning Electron Microscopy) to determine particle size and surface morphology, while XRD (X-Ray Diffraction) is used to verify the crystallinity of the nanocrystals.
- **Chemical Verification**: FTIR (Fourier Transform Infrared Spectroscopy) confirms the chemical modifications and the success of the deacetylation process, complemented by pH-metric titration to determine the exact degree of deacetylation.
- **Stability Testing:** TGA (Thermogravimetric Analysis) and DSC (Differential Scanning Calorimetry) are being used to evaluate thermal stability.