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Systematic Evaluation of Methoxypolyethylene Glycol Amine (mPEG) Molecular Weight on the Colloidal and Solid-State Characteristics of End-Grafted Cellulose Nanocrystals

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Cellulose nanocrystals (CNCs), derived from renewable sources, are cholesteric liquid crystals with desirable morphological and mechanical properties, such as high aspect ratio, low density, and high Young's modulus [1]. Surface modification of CNCs with new chemical functionalities provides a means to expand their potential applications, however this often perturbs the interparticle forces necessary for liquid crystal phase formation [2]. CNC reducing end group modification is a promising approach to preserve their anisotropy and self-assembly properties [3]. In this study, CNCs were end-grafted with methoxypolyethylene glycol amine (mPEG) via reductive amination reactions, and the effects of different molecular weights of mPEG (1000, 5000, and 10000 Da) were systematically evaluated by ANOVA one way analysis, considering CNC behavior in solution and solid film properties.After confirming reducing end group binding, the size distribution and stability of mPEG-CNCs was measured by atomic force microscopy (AFM) and Dynamic light scattering (DLS). In addition, thin films of mPEG-CNCs were characterized by polarized optical microscopy (POM). Furthermore, roughness and hydrophobicity were measured by AFM and three-phase contact angle, respectively. The results showed that while end grafting did not significantly change size distribution, the zeta potential changed dramatically. In addition to maintaining their self-assembly properties, this could significantly enhance dispersibility, stability, and functionality. We propose that end-grafting of mPEG to CNCs provides steric hindrance, which reduces attractive intermolecular interactions and improves dispersion in aqueous and polymer matrices. We foresee mPEG-CNCs as a class of colloidal liquid crystal hybrid to be used as new building blocks for bottom-up assembly of cholesteric structures.

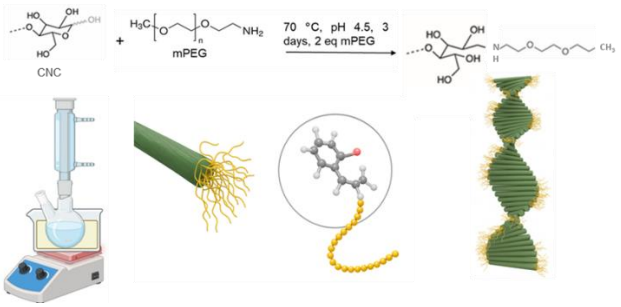

Figure 1. *mPEG-Grafted CNCs: From Surface Reaction to Ordered Assembly*

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