A Novel Approach for Tuning Chiral Nematic Structures in Cellulose Nanocrystal Films

Wojtania, Nicky

Color is an important aspect of human life and one day structural colors, never fading and mimicking nature, could replace toxic pigments. Aqueous suspensions from Cellulose Nanocrystals (CNC), extracted from cellulose, self-assemble into chiral nematic structures creating free-standing iridescent colored films upon drying. These nematic structures have unique optical properties like structural color. It was hypothesized that changing the solution evaporation rate impacts nematic structures, shifting the structural color and improving uniformity. First, the conditions (CNC concentration, sonication time, casting) to create iridescent films reflecting wavelengths in the middle of the visible spectrum were empirically derived. The self-assembly process was then investigated in detail. The experiment's novel aspect was to decelerate (apply custom masks) or accelerate (apply fans) the solution evaporation at targeted self-assembly phases. An UV/Vis/NIR Spectrophotometer measured the film's reflected wavelength, a Polarized Optical Microscope examined nematic structures, and circularly polarized filters determined chirality. The experiment confirmed that changing the solution evaporation rate after self-assembly began influenced the film's optical properties and consistency. Decelerating the solution evaporation rate shortened the nematic helix, blue-shifting the color. The nematic structure size increased, improving film uniformity. Accelerating the solution evaporation speed extended the nematic helix, red-shifting the color. This significant discovery to better control nematic structures brings CNC (most abundant biopolymer) closer to many industrial applications, like using them for pigment replacement, UV reflecting materials, optical encryption, and photonic crystals.