Preparation of electrically insulated CNC-Polymer Composites with High Orientation for Electric Applications

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Cellulose Nanocrystals (CNC), a widely researched cellulose-based nanomaterial, have attracted significant attention over the past two decades. This interest is driven by CNC's promising attributes, which include excellent thermal stability, optical transparency, electrical insulation, and piezoelectric properties. To fully utilize the advantages of CNC, CNC based materials must be prepared in a way in which CNC in the materials has a high orientation. A great deal of research has been done and a very high orientation degree of CNC has been achieved in pure CNC films by using shear casting during the fabrication process.

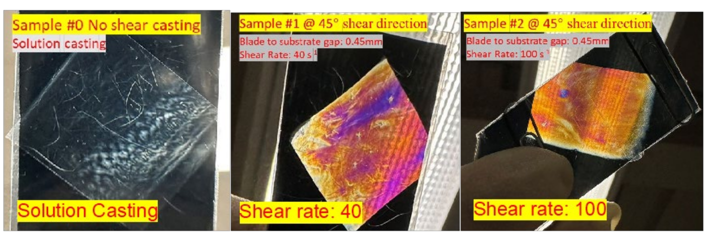

Fig.1 Shear casting P(VDF-HFP)-CNC (30 wt.%) composite under cross polarized

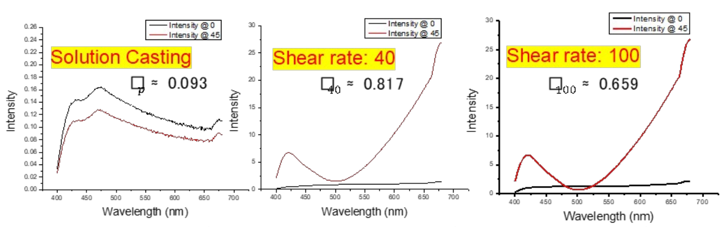

Fig.2 Shear casting P(VDF-HFP)-CNC (30 wt.%)'s UV–visible spectrum

However, pure CNC film tends to be brittle, limiting its utility in wearable electronics or devices. Therefore, a composite approach has emerged as a potential solution to this issue. The fabrication of the composite necessitates solvent exchange due to the inherent hydrogel form of CNC and the significant impact of water molecules on the composite's electrical properties. In this study, we utilized a multi-step approach combining freeze-drying, ultrasonic redispersion, and shear casting techniques for the preparation of CNC-P(VDF-HFP) composites. This methodological framework is designed to effectively remove water and realign the CNC within the P(VDF-HFP) matrix, optimizing the electrical properties of the composite. As depicted in the figure1 and 2, the shear-casting sample subjected to a shear rate of 40 demonstrates the highest order parameter, reaching 81.7%. The results presented in the figure indicate that the samples obtained through this method exhibit excellent flexibility and transparency.

Keywords: Cellulose nanocrystal, all organic composite, reorientation, composite