TRICOMPONENT COMPOSITES WITH CELLULOSE NANOCRYSTALS AND CHITIN NANOFIBERS – EXPLORING POTENTIAL SYNERGY THROUGH COMPONENT INTERACTIONS

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Bio-based materials are being investigated increasingly as alternatives for synthetic materials in a variety of application areas, including composite materials. Among the options for bio-based materials, cellulose and chitin are abundant and increasingly available in different forms, including nanofibers. Due to their anticipated mechanical properties and anisotropic structure, nanofibers of cellulose and chitin lend themselves naturally for use as reinforcing fillers in polymer matrix composites, and the use of each in composites has been studied. However, composites containing both nanofillers has been explored to a lesser extent, and this composite design may provide benefits beyond those seen when the nanofibers are used separately. Therefore, the objective of this work is to examine how nanoscale forms of cellulose and chitin may be used separately and together in composite constructs. Specifically, we are preparing and characterizing composites composed of cellulose nanocrystals (CNCs) and/or chitin nanofibers (ChNFs) in a poly(vinyl alcohol) (PVA) matrix to understand more fully how component interactions affect the structure-property relationships in these materials and how these interactions may be used to produce synergistic improvements. For the specific CNCs and ChNFs used in this work, the nanofillers have opposite surface charge, with CNCs having a negative surface charge and ChNFs having a positive surface charge. Additionally, the components have an ability to interact through hydrogen bonding. These different types of interactions are anticipated to play a role in the structural development in the composites through the processing steps. To probe the effect of these interactions further, we have studied consolidated films as well as hydrogels. The results of these studies indicate that composites containing certain CNC/ChNF ratios possess better mechanical properties than composites containing only one type of nanofiber. Additionally, composites containing CNC/ChNF ratios where surface charges are more evenly balanced experience increased aggregation, presumably due to charge-driven association between the fillers. Mechanical property trends in consolidated films and hydrogels were qualitatively similar, suggesting a general behavior resulting from the component interactions.

References

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