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# Increasing dispersion, performance, and pot-life in cellulose nanocrystal/waterborne epoxy composites

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# INCREASING DISPERSION, PERFORMANCE, AND POT-LIFE IN CELLULOSE NANOCRYSTAL/WATERBORNE EPOXY COMPOSITES

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Recent emphasis on the pilot scale production of cellulosic nanomaterials, cellulose nanocrystals (CNCs) and cellulose nanofibrils (CNFs), has increased interest in the effective use of these materials as reinforcements for polymer composites. These studies have been motivated in part by the combination of attractive specific mechanical properties of cellulosic nanomaterials as well as their renewable and possibly sustainable manufacturing routes. The objective of this research complements these efforts and is concerned with more fully understanding the materials design space available for CNC reinforced polymer composites, specifically CNC/waterborne epoxy composites. These composites were processed using different protocols and the structure and properties of the resulting materials were characterized [1, 2]. The different protocols were termed one-step and two-step mixing, and the order of component addition was different in these methods. Relatively simple changes in processing resulted in significant differences in CNC dispersion (Figure 1) and physical properties. These changes were attributed to an association between the CNCs and the epoxy particles in the emulsion, similar in nature to a Pickering emulsion. Both processing protocols produced composites with improved mechanical properties relative to the neat epoxy, but the magnitude of the changes were dependent on the processing. Changes in glass transition temperature and thermal degradation were not sensitive to the processing method when observed in the as-processed condition. Additionally, the CNC colloidal stabilization mechanism was explored to incorporate freeze-dried CNCs into the epoxy/crosslinker formulation, resulting in an extension of the pot life by three orders of magnitude compared to the neat system. Overall, these results indicate that CNCs produced at pilot scale can be incorporated effectively into waterborne epoxies, leading to the development of higher performing composites for coating applications as well as the potential for the formulation of a one-part epoxy stabilized by CNCs.

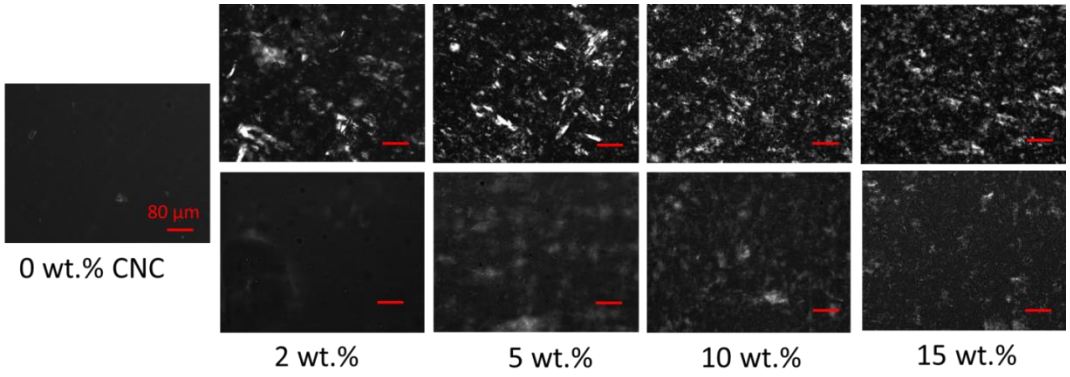


*Figure 1 – Polarized light microscopy images of CNC/epoxy composites. Top: one-step mixing, bottom: two-step mixing [1, 2]. Lesser birefringence was observed for samples produced by two-step mixing, indicating that CNCs domains were smaller.*

References

1. Girouard, N., G.T. Schueneman, M.L. Shofner, and J.C. Meredith, *Exploiting colloidal interfaces to increase dispersion, performance and pot-life in cellulose nanocrystal/waterborne epoxy composites.* Polymer, Accepted.
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