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Cellulose-based conducting nanocomposite films via spray deposition with in situ GISAXS

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In the emerging field of printable electronics there is a growing demand for transparent, flexible conductive materials. Cellulose-based substrates are a promising sustainable alternative to fully synthetic polymers. We present the fabrication of conducting composite films of cellulose nanofibers (CNF) and poly(3,4-ethylenedioxythiophene)-poly(styrenesulfonate) (PEDOT:PSS). CNF of high surface charge are produced with TEMPO (2,2,6,6-tetramethylpiperidine-1-oxyl radical)-mediated oxidation and mixed with PEDOT:PSS in aqueous dispersion. Composite films are produced with a spray deposition followed in situ with GISAXS with sub-second time resolution. GIWAXS applied to the final films was used for the investigation of crystallinity in the composite. Different CNF/PEDOT:PSS ratios and the influence of the additive glycerol were investigated. The changes of the morphology and the influence on electric conductivity with the introduction of a compositional gradient are discussed. As the synchrotron-based investigation allowed for a high temporal resolution of 0.1 s, insights into the very first stages of the deposition process were obtained. The increase in conductivity can be explained by a change of morphology in the meso- and the nanoscale. The in situ investigation of the CNF/PEDOT:PSS composites are consistent with the application of glycerol as a plasticizer allowing for morphological changes especially with elevated temperatures as used with the spray deposition process.

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