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Conducting polymer infiltration in porous cellulose thin films

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Cellulose nanofibrils (CNF) have proven their strengths in conductive and transparent films. A promising route for fabricating porous CNF films on large scale is spray deposition using water-based technologies; the resulting porous CNF templates are excellent candidates to infiltrate conductive polymers for functionalization. We used poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS), widely applied in organic photovoltaics and electronics, to functionalize the CNF template. We studied the infiltration, resulting structural rearrangement within the thin CNF film of 400 nm thickness, and their behavior under cyclic humidity changes by grazing incidence small-angle neutron scattering. We resolve in situ reversible morphological rearrangements within pristine CNF thin films under cyclic humidification, which might be attributed to voids or coiling. When infiltrating PEDOT:PSS, morphological changes within the film are inhibited due to the polymer completely filling any porous structure within the thin film during cyclic humidification. The CNF/PEDOT:PSS composite obtained by infiltration rather shows a swelling process of the PEDOT:PSS component in the film. This behavior is reversible over at least two humidification cycles. As humidity is present in many device applications and during processing and fabrication of conductive CNF composites, our results help to understand the humidity's nanoscale impact to the meso- or macroscale in a device application.

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