High-throughput roll-to-roll X-ray characterization of polymer solar cell active layers - DTU Orbit (23/04/2019)

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Synchrotron-based X-rays were used to probe active materials for polymer solar cells on flexible polyester foil. The active material was coated onto a flexible 130 micron thick polyester foil using roll-to-roll differentially pumped slot-die coating and presented variation in composition, thickness, and additives. The coated foil was passed through a synchrotron X-ray beam on a small unit comprising unwinder and winder for the foil, an X-ray probe station, and a barcode reader for sample registration. Foil lengths of 10 meters were probed and yielded X-ray scattering data for approximately every 1 cm, probing linear variations in processing and coating parameters along the foil. The demonstration shows that real-time structural characterization of roll-to-roll coating at realistic web-speeds is feasible using synchrotron radiation. Off-line characterization with lower spatial resolution would be possible with dedicated laboratory instruments. We found that poly(3-hexyl)thiophene (P3HT) only crystallizes at a ratio above 1 : 2 with phenyl-C61-butyric acid methyl ester (PCBM) and that an optimum addition of 2 vol% chloronaphthalene (CN) as a processing additive significantly improves polymer crystallinity and crystallite size. In coated films thinner than 275 nm, textured poly(3-hexyl)thiophene crystallites with the lamellar stack aligned with the substrate dominate, similar to what is observed for spin-coated films.

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