Structure and morphology determination of organic devices with soft x-rays

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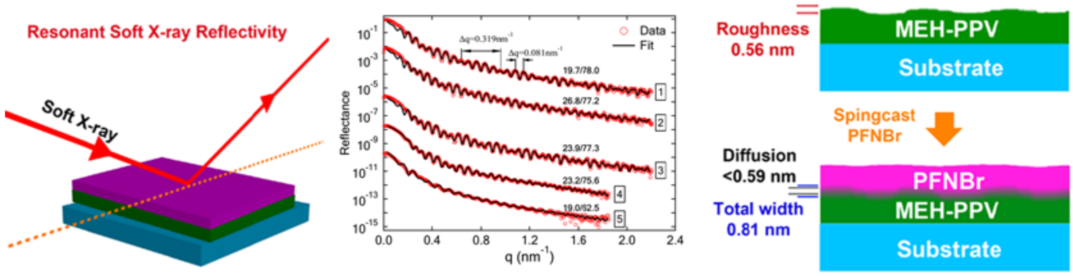
Soft x-rays are more strongly absorbed than hard x-rays, particularly just above an absorption edge. Furthermore, right near the absorption edge, fine structure in the absorption coefficient, β, is encountered that is directly related to the electronic and hence molecular structure of materials. This high cross-section and spectroscopic correlation is pronounced for carbonaceous materials and has been exploited for some time now for the characterization of polymeric materials with zone plate based soft x-ray absorption microscopy. The rapidly changing absorption coefficient as a function of photon energy is, through a Kramers-Kronig relations, correlated to a rapidly changing index of refraction decrement δ. This relation has been exploited recently to provide tuneable contrast for x-ray scattering and x-ray reflectivity above and below an absorption edge and for high scattering intensity for scattering from thin films. We review the basic physics of soft x-ray interactions with matter and exemplify the resulting advantages, disadvantages and capabilities. Emphasis will be placed on the characterization of organic electronic devices.



Characterization of buried polymer/polymer interfaces is a good examples of soft x-ray capabilities. For examples, interfaces of conjugated polyelectrolyte (CPE)/poly[2-methoxy-5-(2'-ethylhexyloxy)-p-phenylene vinylene] (MEH-PPV) bilayers cast from differential solvents have been shown by resonant reflectivity to be very smooth and sharp. The chemical interdiffusion due to casting is limited to less than 0.6 nm and the interface created is thus nearly "molecularly" sharp. These results demonstrate for the first time and with high precision that the non-polar MEH-PPV layer is not much disturbed by casting the CPE layer from a polar solvent. A baseline is established for understanding the role of interfacial structure in determining the performance of CPE-based polymer light emitting diodes. Comparison to device performance in as-cast and annealed devices shows that the best devices are those with the sharpest interfaces.