Abstract:
In this work, we present a solution-processed inverted organic photodetector with a bulk heterojunction of poly(3-hexylthiophene) (P3HT) and [6,6]-phenyl C61 butyric acid methyl ester (PCBM) as photoactive layer and poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) as hole-conductor. By the exposure of the hydrophobic photoactive layer to a low-pressure oxygen plasma the challenge of spin-coating the water-based PEDOT:PSS solution on top of it is overcome. Impacts of the oxygen plasma on the device regarding electrical and material properties were investigated. It is shown that the plasma treatment does not damage the photoactive layer but increases its wettability due to formation of polar oxygen compounds on the surface. These oxides influence the carrier transport due to space charge limited current, leading to a decreased photocurrent for external bias smaller than \(-1\) V, whereas for larger reverse bias the device performance is not negatively influenced. A comparison with non-inverted reference photodiodes is also reported. We found that the main limitation of the inverted devices, a decreased external
quantum efficiency, is not due to the impact of plasma treatment but to the use of a semi-transparent gold anode with a transmission of about 55% @ 500 nm instead of ITO (indium-tin-oxide) used in the reference diodes. Taking this reduced transmission into account, the inverted photodiodes show device performance comparable to the non-inverted devices.