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Characteristics of a Flexible Radiation Detector Fabricated with Non-Fullerene Acceptor for Indirect-type X-ray Imaging

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With noticeable improvements in synthesis and processing of organic semiconductor material, flexible devices are widely studied in various areas such as organic light emitting diode (OLED), organic solar cell, and radiation detector. Among radiation detector applications, dentistry, mammography, and non-destructive inspection areas have a significant interest in flexible and conformable imager. In this study, we proposed the indirect-type and flexible X-ray detector fabricated on polyethylene naphthalate (PEN) substrate with non-fullerene acceptor material. In order to evaluate the performance of the organic detector (Figure 1a) fabricated on glass and PEN substrate, the sensitivity¹⁾ of the detector having P3HT²⁾ and PC70BM³⁾ blended active layer was measured. The sensitivity of the detector fabricated on PEN substrate was 6% lower than that of the detector made on glass substrate due to relatively low transmittance and relatively high contact resistance. Fullerene-based acceptors, such as PC60BM and PC70BM, have issues with high synthetic cost, limited spectral absorption and morphological instability. In order to improve the thermal and mechanical stability of the detector fabricated on PEN substrate, a non-fullerene acceptor, O-IDTBR⁴⁾, was applied instead of PC70BM acceptor. In addition, absorption wavelength of O-IDTBR (Figure 1b) was well-matched with emission wavelength of CsI(Tl) scintillator. Various curvature bending tests (Figure 1c) were carried out to verify its suitability as a flexible detector. After undergoing 30 bend cycles of different curvatures, the detector with the P3HT:PC70BM active layer showed poor stability than the detector with the P3HT:O-IDTBR active layer.

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