

Radiation Damage Characterisation of Organic Semiconductors

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The radiation damage of a fullerene-composite bulk heterojunction organic photodetector was characterised for samples that have been exposed to ionising radiation in increments of 10kGy up to a total accumulated irradiation dose of 40kGy. Irradiation was achieved by a cobalt-60 gamma source (dose rate = 1.2kGy/h) at the Australian Nuclear Science and Technology Organisation. Between each irradiation the Charge Collection Efficiency of the photodetector was measured using an LED (520nm) in a dark environment. Normalised to the Charge Collection Efficiency prior to irradiation, the response after exposure to 40kGy decreased by 40%. The mobility of a photodetector exposed to 40kGy was compared to an un-irradiated sample via the Time-of-Flight method. A picosecond pulsed laser incident upon the sample was used to inject photo-generated charge carriers within the bulk. The measurement of the carrier transient was used to obtain the carrier drift time of the organic photodetector. The drift time at 20V bias was determined to be (2.727 ± 0.002) s and (1.525 ± 0.002) s for the photodetectors exposed to 0 and 40kGy, respectively. The decrease in drift time due to the accumulated radiation damage is associated with a lower charge collection efficiency. Calculation of the drift mobility shows an increase in carrier mobility as a function of radiation damage. This result combined with the drift time measurements suggests that the effective thickness of the device varies as a function of total ionising dose. This effect can be explained by hypothesising a high recombination rate of the irradiated devices and their capability to collect charge carriers only from regions close to the electrodes. A shorter lifetime of the charge carriers in the highly irradiated device is suggested to explain the faster rise and fall time of the transient time. The Charge Collection Efficiency and Time-of-Flight method have provided valuable insight into the effects of radiation damage upon the charge transport characteristics of organic compounds.

Level of Expertise

Student

Do you wish to take part in the poster slam

No

Travel Funding

Yes

Speakers Gender

Female

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