

## Measurements of X-ray Induced Current in Organic Photodiodes

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### Introduction

Organic semiconductors have attracted considerable interest in the fields of photonics devices because of their potential use as flexible photodetectors for large areas.

As radiation detectors, inorganic semiconductor devices have excellent radiation detection properties as biological equivalence with human body. For this study, we fabricated a classical hetero junction OPD and measured its response to mono-energy X-rays. Moreover, a bulk-hetero junction OPD was fabricated with a 300nm-thick mixed organic layer and was applied to the X-ray measurements.

### Experiment

The X-ray measurement experiments were carried out at BL-14, PF, KEK. The energies of X-rays were set to 40keV, 20keV and 10keV.

The structure of the hetero-junction OPD devices was as follows with the sensing area of 4mm x 4mm:

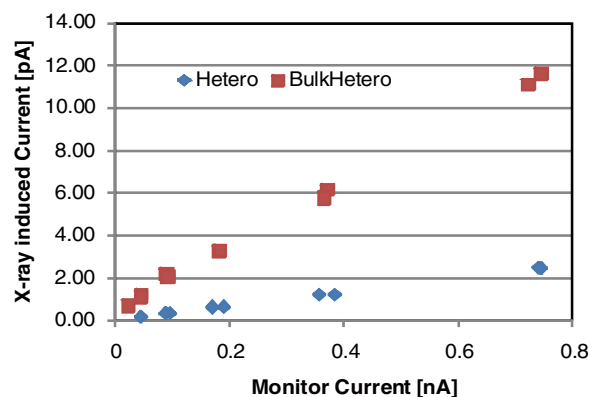
Indium tin oxide (ITO) (150 nm) /  
N,N'-Di(1-naphthyl)-N,N'-diphenylbenzidine  
( $\alpha$ -NPD)(50nm)/  
N,N'-ditridecyl-3,4,9,10-perylene-tetracarboxylic  
diimide (td-PTC) (70 nm) /  
Al (50 nm).

X-ray induced current was also measured for a bulk-hetero junction OPD which had a mixed organic layer of  $\alpha$ -NPD and td-PTC between the layers of  $\alpha$ -NPD and td-PTC. The thickness of the mixed layer was 300nm.

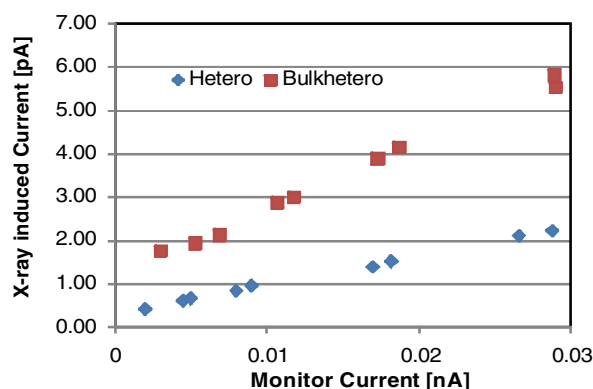
### Results and Discussions

Fig.1 shows the relationship between the monitor beam current measured by the ionization chamber and the X-ray induced current in the hetero-junction OPD and the bulk-hetero junction OPD. It can be seen that, for both devices, the X-ray induced current increased almost linearly with the monitor current.

At X-ray energy of 10keV, the X-ray induced current in the bulk-hetero junction OPD was about 5 to 6 times larger than in the hetero-junction OPD. On the other hand, at X-ray energy of 40keV, the ratio of the X-ray induced current was about 3. It can be understood that at the energy of 10keV, the X-rays and the resultant secondary electrons deposited their energy more efficiently in the mixed organic layer than at the energy of 40keV.



(a) Results with the X-ray energy of 10keV



(b) Results with the X-ray energy of 40keV

Fig.1 X-ray induced current for the hetero junction OPD and the bulk-hetero junction OPD with the X-ray energy of (a) 10keV and (b) 40keV.

### Conclusions

We could observe the X-ray induced current in the OPDs. It was also seen that the measuring efficiency could be enhanced by making a thicker mixed organic layer with the bulk-hetero structure. We will evaluate the charge production/collection efficiency of the devices by combining the simulation with the EGS5 code.

### References

- [1] E. Takada et al., Conference Record of 2009 IEEE NSS/MIC, N25-27, 1295-1299 (2009).

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