Mobility and lifetime mapping in wide bandgap semiconductors using digital IBIC

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We present data acquired using the digital IBIC system recently developed at the University of Surrey's Tandetron accelerator [1]. Digital IBIC performs time-resolved IBIC imaging of electron and hole transport in semiconductors, which produces quantitative maps of drift mobility and carrier lifetime in bulk wide bandgap semiconductors. The use of a temperature controlled sample stage allows the study of mobility and trapping phenomena from 77K to 300K. The primary application for this technique is for the characterisation of the charge transport properties of wide bandgap semiconductors which are being developed for radiation detector applications.

The digital IBIC system developed at the University of Surrey is an extension of the regular IBIC method, in which a high speed waveform digitiser replaces the conventional shaping amplifier and peak-sensing ADC. The waveform digitiser captures the IBIC pulse shapes in real time, and digital pulse shape analysis algorithms are applied to extract parameters such as signal drift time, pulse shape, and amplitude. The minimum time resolution of the pulse shape analysis is currently 10 ns, with a maximum pulse sampling time of 100 ms.

We present quantitative images of electron lifetime and mobility in CdTe, acquired during the recent commissioning of this system. The average room temperature electron mobility in CdZnTe was measured with a value of 1.1×10^3 cm^2/Vs. The application of this technique to temperature-dependent mobility mapping in other materials will be discussed.

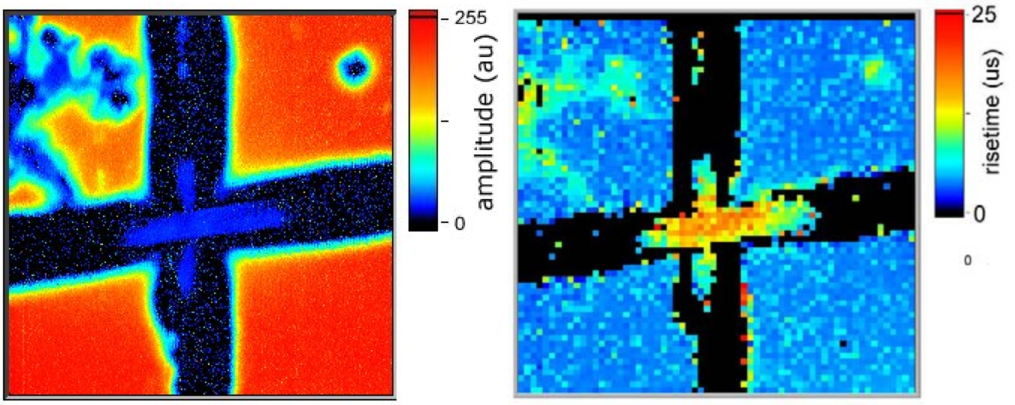

Figure 1(left) conventional IBIC map of signal amplitude from a pixellated CdTe detector. The central dark cross is the inter-pixel region where no there is no metal electrode, (right) the same sample acquired using digital IBIC, showing electron drift time.

[1] PJ Sellin et al, NIM A521 (2004) 600-607

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