InAs pixel matrix detector structures fabricated by diffusion of Zn utilising metal-organic vapour phase epitaxy

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InAs has conventionally been used in infrared detection due to its low bandgap [1]. Theoretically, InAs based x-ray detectors are expected to have an excellent energy resolution due to the low electron-hole pair creation energy provided by the low band-gap. Zinc diffusion utilising a low pressure MOVPE technique has been used in fabrication of InAs infrared detectors [2], and GaAs pixel detectors have been fabricated using zinc diffusion in atmospheric pressure MOVPE [3]. In this paper, we describe an atmospheric pressure MOVPE diffusion process to fabricate an InAs diode matrix, intended for use as a spectroscopic x-ray pixel detector. The diode properties of the fabricated matrices are also characterised.

In the experiment, surface of undoped lightly n-type InAs wafers was converted to p-type by zinc diffusion in a horisontal MOVPE reactor at 500 °C. Diethylzinc was used as the zinc precursor, and tertiarybutylarsine was used as the arsenic supply in order to compensate the desorption of arsenic from the InAs surface.

Two pixel definition methods were experimented. Some samples were coated with SiO_2 before diffusion, and matrices of holes were patterned into the oxide by UV lithography. Diffusion after opening the oxide formed a p-doped region under each hole in the oxide, as illustrated in Fig. 1. Another set of samples was diffused as uncoated, and the pixels were defined by mesa etching. After the pixelation, the lift-off resist mask was spinned and patterned. The four-layer metallisation of Pt-Ni-Pt-Au was evaporated onto the patterned sides of the diodes and the lift-off was carried out in acetone. Finally, the backsides of the chips were metallised with Ni-Au-Ge-Au.

The diode characteristics and inter-pixel resistances were measured from the fabricated pixel matrices. The effects of diffusion parameters and pixelation methods on IV characteristics are discussed.

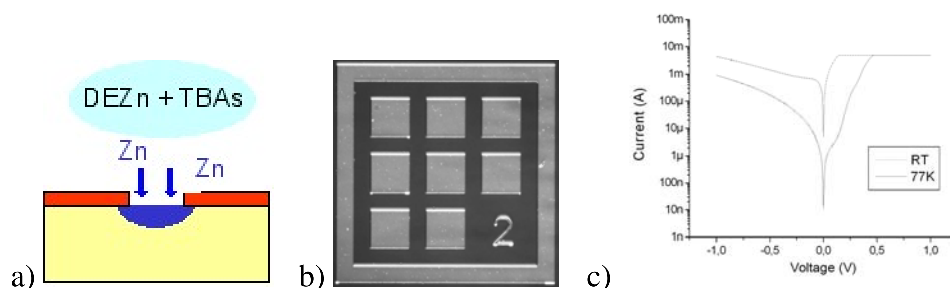

Figure 1: a) Schematic drawing of Zn diffusion process of InAs in the MOVPE reactor. The dark area under the mask hole is the p-doped InAs volume formed by Zn diffusion, b) optical micrograph of a processed test matrix, c) IV behaviour of a pixel in a test matrix (logarithmic current scale).

References

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