Secondary particle detection for deterministic single ion implantation

K. Stockbridge[1], E. Schneider[2], G.Arresta[1], D. Cox[2]

[1] Ionoptika Ltd, SO53 4BZ, Eastleigh, UK

[2] University of Surrey, GU2 7XH, Guildford, UK

E-Mail: k.stockbridge@ionoptika.co.uk

Techniques for deterministic implantation of single ions are currently of high interest for quantum applications that rely on the engineering of single defects in solids such as single photon emitters and solid-state qubits. The Ionoptika QOne single ion implanter achieves deterministic implantation by secondary charged particle (SCP) detection. Provided the ion beam/implant energy/target material combination results in a sufficiently high SCP yield, detection efficiencies up to 100% are possible and have been demonstrated.

Determining the detection efficiency of an ion/target system is vital in calculating the expected error-rate for a particular implant job. A <100% detection efficiency may be the result of low SCP yield (material physics limits) and/or poor conversion of generated particles to detected signal (sub-optimal detector configuration). Separating these two effects is required to fully understand and characterise the performance of the detectors independently of ion/target materials used.

For situations where poor SCP yield is the significant factor limiting high detection efficiency, methods to improve the SCP yield have been investigated e.g., by implanting through thin, high yield deposited material. Alternative detection modes e.g., ion beam induced charge (IBIC), have also been demonstrated in the QOne system.