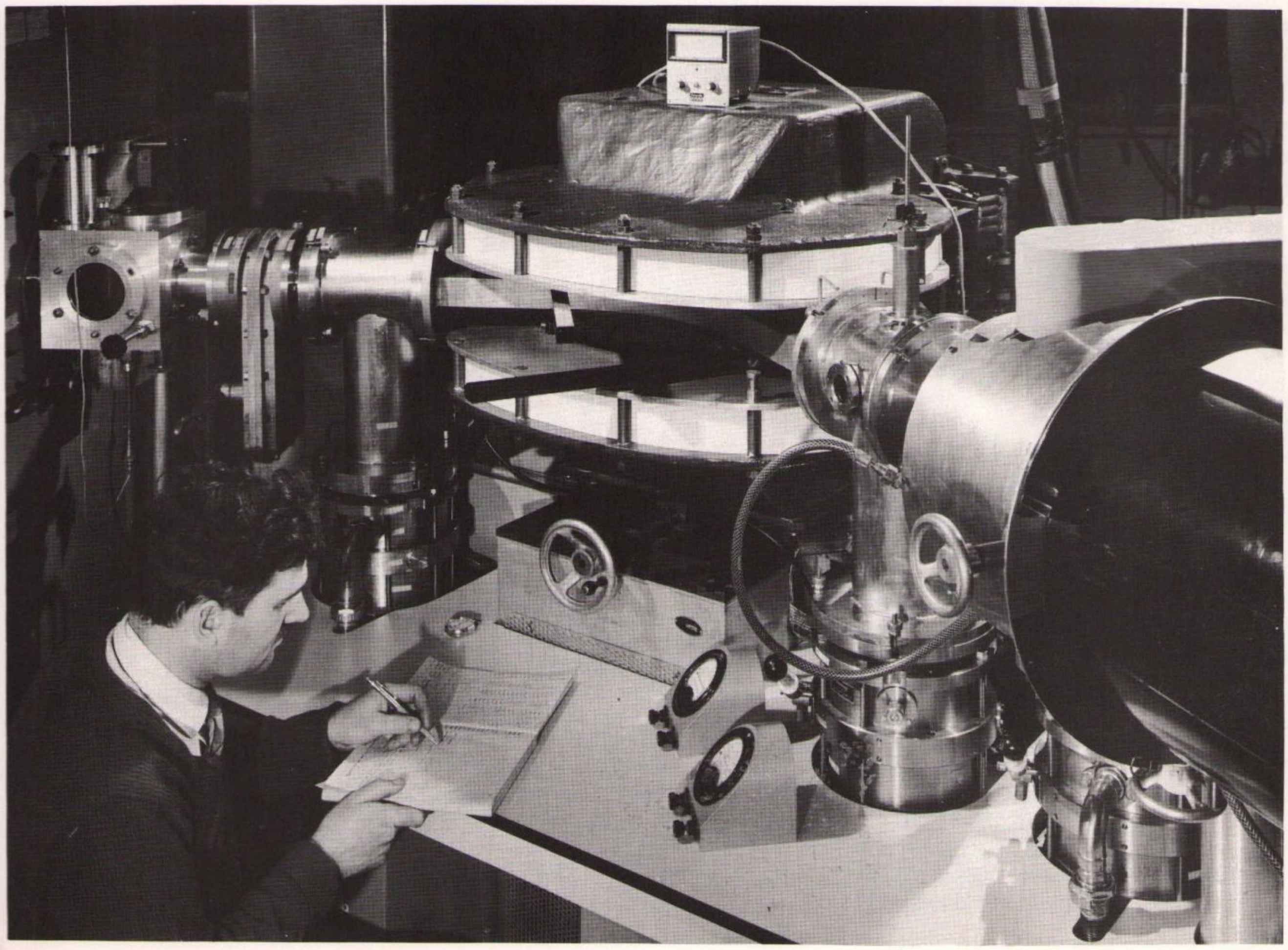
Isotope separators and ion implantation facilities

Two isotope separators offer positive ions of most elements with typical maximum beam currents, for singly charged ions, of >1 mA. The energy range is 5 - 200 keV, but for many applications this can be extended upwards to 400 keV by the use of doubly charged ions. The yield of doubly charged ions is usually in the range 1 - 10% that of singly charged.

One separator is particularly suitable for non-routine experimental work while another machine with its associated target facility (schematic overleaf) is suitable both for repetitive implantation on a production scale as well as for experimental doping of individual specimens.



Facilities

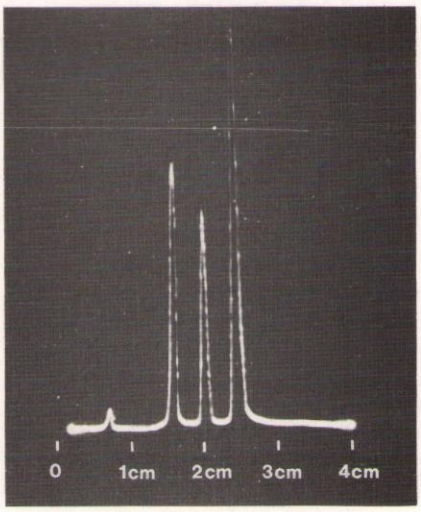
a) A 60 cm radius experimental separator with an aligned target stage which takes single samples of up to 3 cms diameter.

The basic energy of 40 keV can be increased by post-acceleration to 150 keV for singly charged ions and under these conditions the target stage and sample can be maintained at any temperature from ambient to 500°C during implantation.

An alternative cold stage is available to a maximum energy (singly charged ions) of 40 keV. This stage is liquid nitrogen cooled and the temperature can be monitored during implantation.

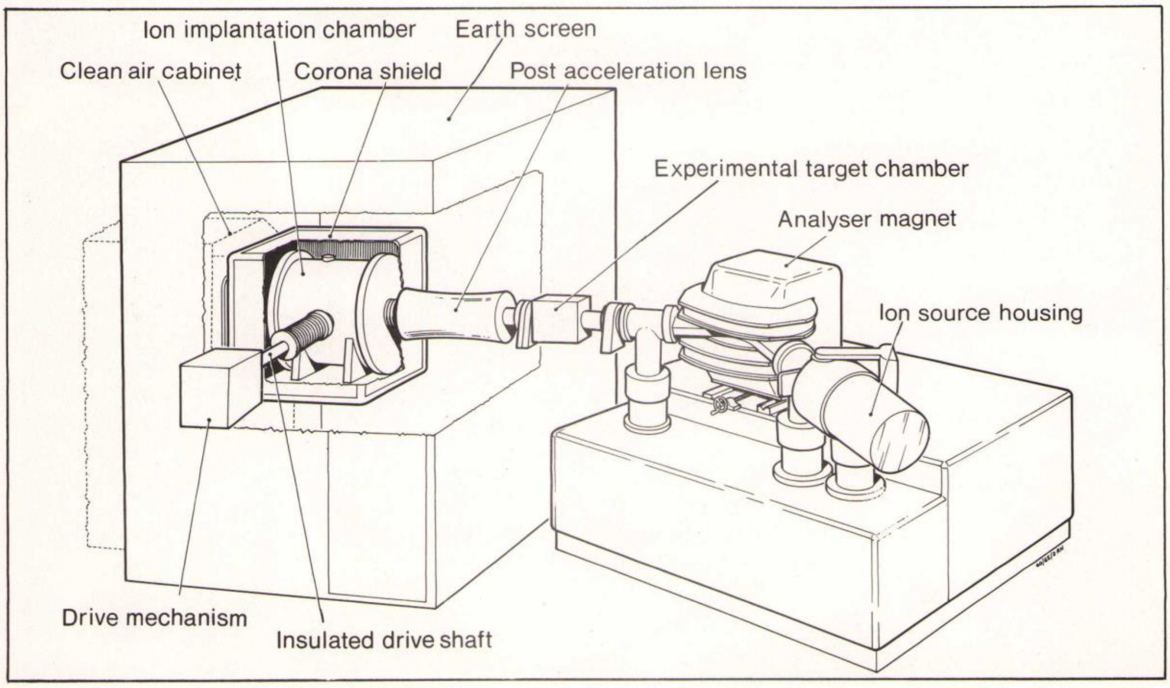
This system is particularly suitable for radioactive implantation or for experiments in which parameters (e.g. energy or dose) are varied from sample to sample. It may also be used in its basic mode as a very high grade electro-magnetic isotope separator.

b) A commercial scale implantation facility consisting of a 40 cm radius variable dispersion separator. The photograph of a 1 mA lead spectrum shows a dispersion commensurate with that of a much larger conventional machine.



This separator is linked to an implantation chamber by a single-stage post-acceleration lens.

The implantation chamber can be loaded with up to twenty target plates each with a useful area of 5 inches x 4¼inches. This area can be implanted quickly with a high degree of overall uniformity. The chamber throughput depends on both the required uniformity and the dose



Doping Uniformity	Throughput 1¼" wafers/hour	Max. doping from ½ mA usable beam ions/cm^{2}
±0.2%	22	2.5×10^{16}
±1.0%	84	5×10^{15}
±2.0%	128	2.5×10^{15}
±3.0%	154	1.7×10^{15}
±4.0%	172	1.25×10^{15}
±5.0%	186	1.0×10^{15}

This table gives an indication of the throughputs which are possible at selected uniformities, also an indication of the relationship of beam current and doping levels at these uniformities.

The implantation rate can be varied to suit specific cases. For example the beam intensity can be restricted to limit the maximum temperature reached by samples during implantation. Such limitation increases the time required to reach a specific doping level, with a corresponding decrease in chamber throughput.

The target plates can be accurately aligned, with respect to the beam, in the angular range from normality to 7^{o} off normality.

Sample handling is performed in a laminar-flow, air-curtained, clean air cabinet which has direct access into the target chamber. A Millipore-filtered supply of dry nitrogen is available in the clean air cabinet for final removal of any particles from the surfaces which are to be implanted

This facility is suitable both for repetitive doping operations at batch scale and for the experimental implantation of individual specimens.

Typical applications of the facilities

1. Doping of semi-conductor wafers can be performed in batch quantities or on single experimental wafers. Doping levels from 10^{11} to 5×10^{16} ions/cm^{2} are easily available and levels outside this range can be arranged. Clean handling facilities are routinely used.

2. Radioactive implantations for hyperfine interactions and for range, channelling or wear studies are regularly carried out. Advice on availability of suitable tracer nuclei can be given.

3. "Hot atom" chemistry

4. Surface modification for hardening or for superconductor studies.

5. Surface coating by sputtering or low energy deposition.

6. Implantation into powders. Techniques for implantation into powders have been evolved and are now established. Samples in the hundreds of gramme range are feasible.

7. Enhanced diffusion studies or applications in high current, large area implants.

Terms of Business

1. Charges
Implantation work is normally charged at a fixed daily rate. Special terms can be negotiated for machine trials or for large-scale repetitive requirements.

A minimum charge is made for simple elements such as boron or phosphorus which can be run from an external vapour feed system. For elements such as arsenic or antimony, which involve loading the ion source with a solid feed material, the minimum charge is increased

2. Target Loading
For large-scale, or particularly difficult requirements, an additional charge may be made for sample

(Overleaf)

handling unless this is carried out by the customer.

For customers with repetitive requirements involving large numbers of wafers, special transport plates can be manufactured which enable the samples to be loaded in the customer's laboratory and then sealed in dust-free containers. The plates can subsequently be loaded into the implanter, via the clean air facility without further handling. Such inserts have been despatched by post and air freight to a variety of customers without damage to wafers.

3. Delivery

Implantations can usually be completed within two weeks of receipt of samples. Samples are normally returned to the customer by post (in Great Britain) or air freight. The standard packaging system has been well tried in transferring silicon wafers without breakage. Should the customer require special packaging this can be arranged.

4. Confidentiality

All implantation work is treated as strictly confidential.

Enquiries on these facilities should be made to:
Mr. G.A. Gard,
Chemistry Division,
Building 7,
A E R E Harwell,
Oxfordshire.
Telephone: Abingdon (0235) 24141
Extension 2625.

Harwell Design Studio No. 26/1974