DEVELOPMENT OF THE PROTON MICROPROBE FOR THE SURFACE ANALYSIS

K.Okuda, K.Saneyoshi, M.Ogawa and E.Arai*

Dept.of Energy Sciences, Tokyo Institute of Technology
*Research Laboratory for Nuclear Reactors, Tokyo Institute of Technology

Abstract

A microprobe system for investigating surfaces of materials is developed in Tokyo Institute of Technology. Using a triplet of electro-static quadrupoles and stabilizing the beam trajectory by the beam-energy homogenizer, a proton beam of 3MeV has been focused in the region of 15-15μm squares. A data acquisition and beam scanning system is also described.

1. Introduction

A microprobe in conjunction with the technique of PIXE is a very useful tool for investigating two-dimensional elemental distributions of surfaces of materials.[1),2)] Although the X-ray micro-analyzer is used for the same purpose, the sensitivity is very lower than that of PIXE because of the high background caused by the bremsstrahlung radiation of the primary electrons.

The elemental distribution is a very important information for the study of radiation damage of materials. Our first object is to achieve the spatial resolution of 10μm and the beam density of 100pA·μm^{-2}.

2. Experiment

The arrangement of the system is shown schematically in Fig.1. A proton beam from the Van de Graaff accelerator is focused onto the horizontal slits which used as the senser of the beam-energy homogenizer. Output of the homogenizer are fed to a pair of deflectors in order to increase the beam transmission through the horizontal slits.

The beam is finally focused by a triplet of electro-static quadrupole lenses. the triplet has a total length of 225mm. Each lens consists of four columnar electrodes with a diameter of 10mm. A spacing between the opposing electrodes is 8.62mm. Three lenses are 50, 100 and 65mm long, respectively. Each component of the lenses was machined with an accuracy of better than 50μm. The focal length of the triplet is 180mm by applying a voltage of about ±8kV to the electrodes.

The measurement of the beam spot size was achieved by swinging the beam across the edge of a copper plate and measureing the beam current. Typical data of these integral methods are shown in Fig.2a. The beam position calibration was made with the Cu grids whose lines were 35μm wide and the repeat distance was 250 μm(Fig.2b). The best spot size obtained was 9-10μm squares and the beam density was 97pA.μm^{-2}.

3. Beam scanning and data acquisition system

The schematic diagram of the beam scanning and data acquisition system is shown in Fig.3. The minicomputer records the energy of the X-rays event by event together with the positions of the beam spot. The microcomputer generates clock signals which

advance the beam spot position, and displays the two-dimensional distribution of an element of interest on CRT.

References

(1) J.A.Cookson,A.T.G.Ferguson and F.D.Pilling, J.Radioanal. Chem. 12(1972)39.
(2) F.Watt,G.W.Grime,G.D.Blower,J.Takacs and D.J.T.Vaux, Nucl. Instr. and Meth. 197(1982)65.

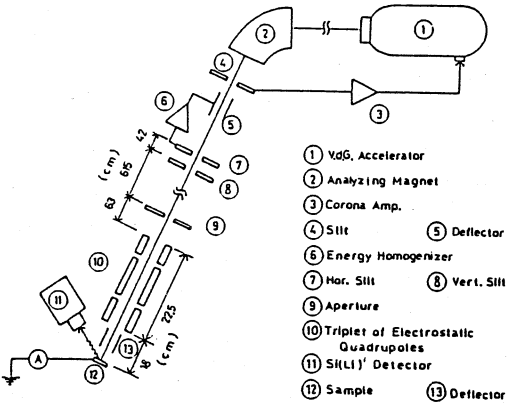

Fig.1 Schematic arrangement of microprobe

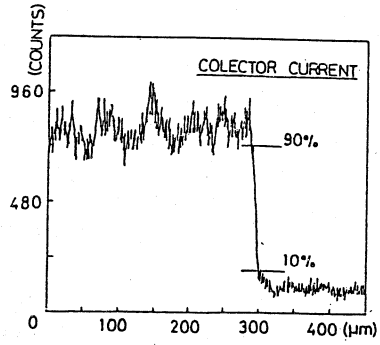

Fig.2a Integral spectrum of beam spot size

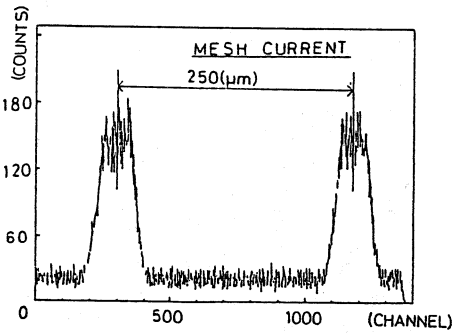

Fig.2b Beam current spectrum with the Cu grids for position calibration

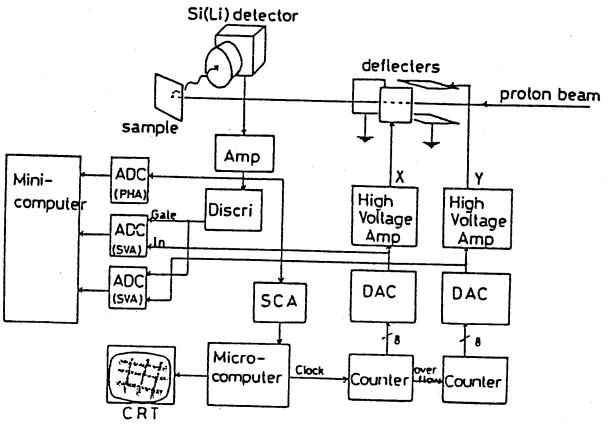

Fig.3 Data aquisition system