Microsc. Microanal. 8 (Suppl. 2), 2002
DOI 10.1017.S1431927602105459

Auger Analysis Of Focused Ion Beam Prepared Lift-Out Specimens

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The Focused Ion Beam (FIB) Lift-Out Technique has been widely utilized by the semiconductor industry for preparing efficient, site specific Transmission Electron Microscopy (TEM) specimens. [1,2] The Energy Dispersive Spectrometry analysis capability of TEM or STEM offers good spatial resolution yet limited elemental concentration detection. Auger Electron Spectroscopy is often used for defect particle analysis because it provides spatial resolution on the order of 20 nm with a detection limit below 1% atomic concentration.

Earlier analyses of in-situ lift out specimens using Auger suffered from the mounting of the specimen on a carbon covered TEM grid. If the specimen was sputtered inthe Auger system, the carbon layer could easily be compromised and the specimen would become wrapped in the carbon film. Sputtering is commonly used in Auger analysis to remove surface contamination or to obtain an Auger depth profile.

A method was developed to reliably take advantage of the site-specific aspect of the Lift-Out technique using Auger analysis. A cross sectional lift-out specimen was prepared using the FIB. In this procedure, a protective Platinum line was first deposited by ion beam assisted chemical vapor deposition. FIB cuts were then made as previously described to separate the specimen from the matrix [1]. The final cross sectional membrane measured approximately 0.2 µm thick, 20 µm wide and 6 µm deep.

Rather than transferring the membrane to a carbon film grid, as is done for TEM analysis, the membrane was placed on a bare silicon substrate using a micro-manipulator. The FIB polished surface of the membrane showed good adherence to the smooth surface of the silicon substrate. FIG. 1 shows an Auger secondary electron image of the lift-out specimen on silicon. FIG. 2 is an Auger survey analysis of the specimen at site 2. The survey shows Si, C, O, and Ga. Results were similar for all three sites. The Ga from the FIB milling can be removed using subsequent sputtering in the Auger system.

The lift-out method has shown versatility by applications to a wide range of material systems. Cross sectional and plan view orientations have also been obtained. It is expected that this new mounting approach will also be applicable to many materials. The thickness of the specimen can be varied depending on the application. Further work will explore the use of mounting surfaces other than silicon.

[1] L. A. Giannuzzi, et al., Materials research Society Symposium Proceedings, 480 (1997) 19.
[2] L. A. Giannuzzi and F. A. Stevie, Micron 30 (1999) 197.

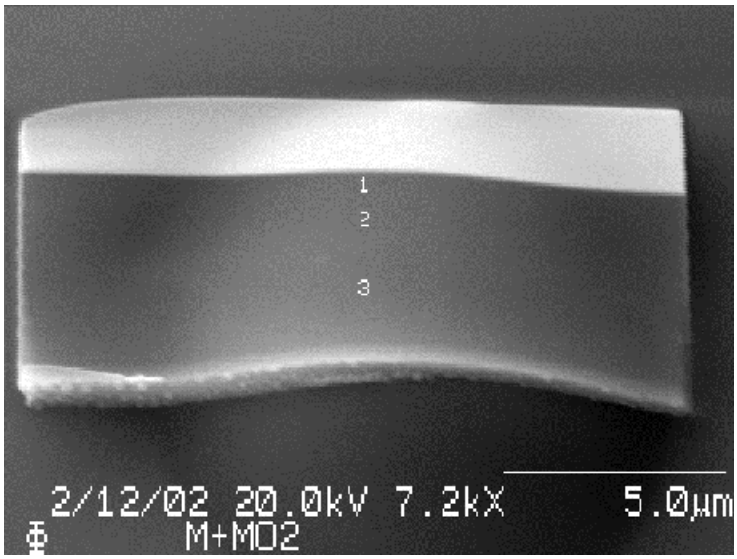

FIG. 1 Auger secondary electron image of lift-out specimen. Auger analysis was conducted at the three sites shown.

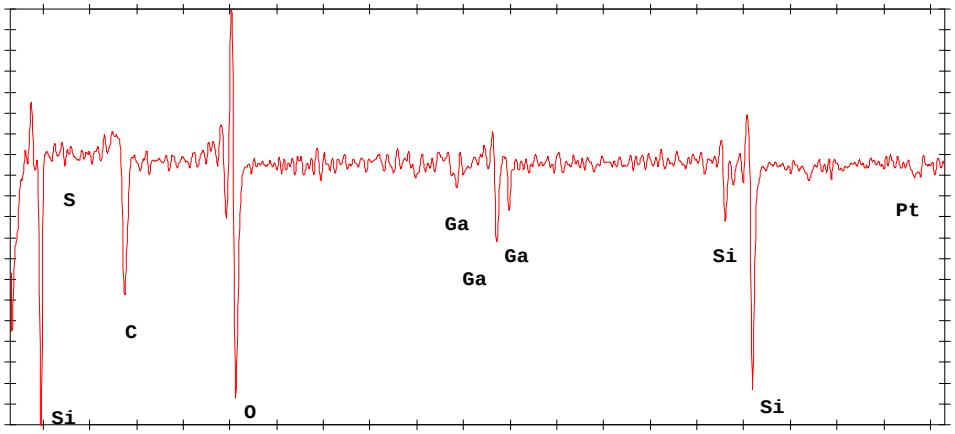

FIG. 2 Auger survey analysis at site 2.

https://doi.org/10.1017/S1431927602105459 Published online by Cambridge University Press