doi:10.1017/S1431927611004041
Microsc. Microanal. 17 (Suppl 2), 2011
© Microscopy Society of America 2011

Advanced Physical Failure Analysis Techniques Using 3D Rotation Imaging from Plane-View TEM Sample

Hyo-Jin Kang, Jae-Gon Gwak, Tae-Su Park, Tae-Sun Back, Ho-Joung Kim, and Oscar Han

Research and Development Division, Hynix Semiconductor Inc., San 136-1, Ami-ri, Bubal-eub, Ichon-si, Kyoungki-do 467-701, Korea

Dual beam focused ion beam (DB FIB) systems have been widely used for transmission electron microscopy (TEM) samples preparation in failure analysis for semiconductor device [1-2]. However, the sampling size of TEM sample is very limited, particularly for a cross-section and three-dimensional (3D) sample. Therefore failure area by electrical test is usually too large to give accurate defect location. As a result, the failure site must be accurately located before FIB milling to prevent from missing target. FIB technique for dual-direction TEM analysis using both plane-view and cross-section samples from the same site previously has been reported because the plane-view sample has large area of inspection and therefore allows one easily capture the failure site [3]. However it would be difficult to prepare TEM sample since this technique needs attach and detach processes several times. It is also difficult to prepare samples for plane-view and 3D TEM observation which would be an effective method to resolve the physical failure analysis. This results in a less comprehensive understanding of failure structures. To address the above mentioned difficulties, we used the FIB/STEM system equipped with compatible sample rotation holder which allows fast and easy sample preparation [4-5].

In this work, we newly developed FIB sample preparation techniques where both plane-view and cross-sectional sample are performed on a single STEM specimen using rotation holder. We also demonstrated advanced techniques of plane-view and 3D STEM sample from the same site.

FIG. 1 and FIG.2 show schematic drawing of FIB sample preparation for cross-sectional and 3D sample from plane view sample, respectively. FIB sample preparation was used by Hitachi NB-5000 FIB equipped with compatible sample rotation holder which allows a 360-degree rotation of the sample both the FIB system and the TEM/STEM. The cross sectional and 3D STEM observations were performed with Hitachi HD2700. FIG. 3 shows TEM image of (a) plane-view and 3D observation at different rotation angles with (b) 0, (c) 90, (d) 180 degrees prepared from plane-view sample. It has been confirmed that the failure is due to silicon substrate dislocations which could induce leakage current.

References

[1] J. Mayer et al., MRS Bulletin, vol 32, (2007) 400.
[2] R. Langford*, Basics and Applications,* Cambridge University Press, 2007.
[3] J. Zhu et al., *Physical and Failure Analysis of Integrated Circuits (IPFA)* (2010) 1
[4] T. Yaguchi et al., *Microsc. Microanal.* (2003) 118.
[5] T. S. Back et al., *Microsc. Microanal.* 15(Suppl. 2) (2009) 338.

https://doi.org/10.1017/S1431927611004041 Published online by Cambridge University Press

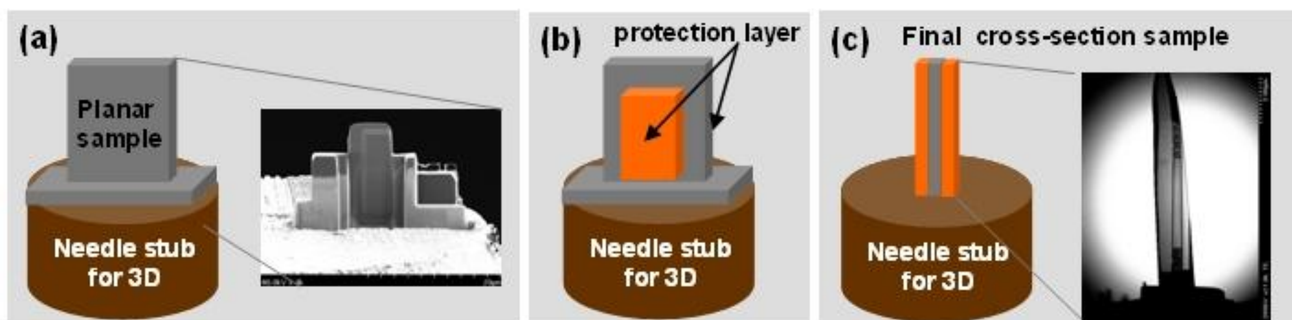

FIG. 1. Procedure for preparing plane-view and cross section samples preparation on a single STEM specimen using rotation holder.

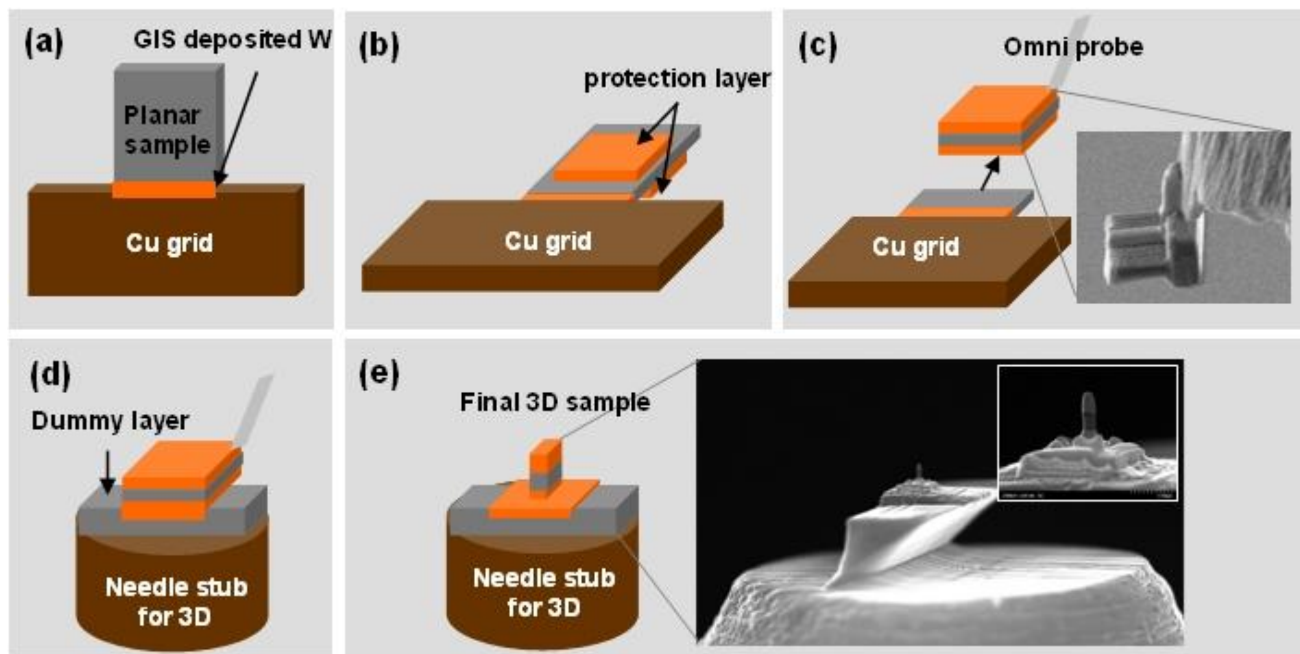

FIG. 2. Procedure for preparing 3D TEM samples from plane-view sample.

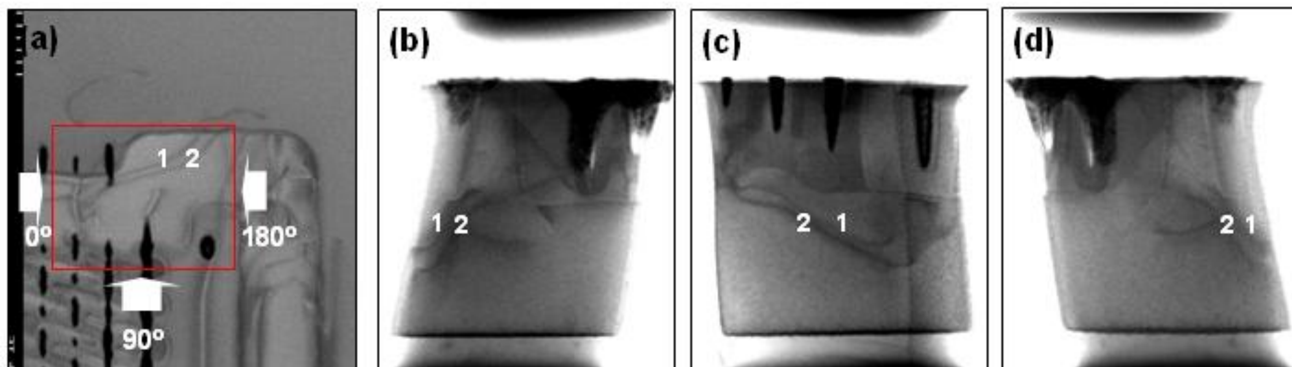

FIG. 3. STEM images of (a) plane view sample and 3D sample at different rotation angles with (b) 0, (c) 90, and (d) 180 degrees.

https://doi.org/10.1017/S1431927611004041 Published online by Cambridge University Press