Application of transmission EBSD in aluminium metal layer and GaAs/AlAs epitaxial layers

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Introduction

Background
As a powerful tool to analyze crystallographic and grain boundary information, EBSD has been widely employed in semiconductor industries. However, the lateral spatial resolution of EBSD (~100 nm) limits the applications of EBSD in semiconductor industries with aggressive size-shrinking trend. In this paper, the t-EBSD (transmission EBSD) configuration [2] is demonstrated to analyse the semiconductor-related materials.

Objective
• Instead of conventional EBSD which uses the backscattered electron, a novel configuration which utilizes the transmitted electron from a thin sample is demonstrated.
• EBSDs are properly indexed in order to construct the EBSD mapping.
• Monte Carlo simulation is used to compare the electron-sample interaction between conventional and transmission EBSD. The lateral resolution can also be estimated by the simulation.

Results and discussion

Fig. 1 shows the t-EBSD result of the cross-section of Al pad specimen. Different Al grains show different EBSP. All the patterns are well-defined and indexable. In the mapping, the grains with the size from 20nm-500nm were revealed. The appearance of the grain with 60 nm indicates the lateral spatial resolution of t-EBSD on the sample surface is better than conventional EBSD.

Fig. 2 Monte Carlo simulation of electron trajectories in conventional EBSD (a) and transmission EBSD (b) on aluminium surface.

Fig. 3 shows the t-EBSD results of GaAs/AlAs layered samples. The kikuchi bands in the EBSPs are well defined. GaAs and AlAs have similar crystal structures with only 0.1% lattice mismatch. Therefore, it is unable to distinguish different layers by indexing the EBSP. In fact, the elastic scattering cross sections are different between GaAs and AlAs due to their different atomic weights. By using their average atomic weights, the total electron elastic cross section values Ω of GaAs and AlAs can be estimated as 5.5 E-17 cm2 and 7.4 E-17 cm2 respectively. Larger Ω value means more elastic scattering events occur. Therefore, more elastic scattered electrons from GaAs contributing to the intensity of kikuchi bands arise from the background in EBSP as compared to that of AlAs, which results in higher kikuchi band contrast in EBSP.

Transmission configuration of EBSD is successful demonstrated. Such configuration pushes EBSD beyond its lateral resolution limits and can be applied to analyze aluminum metal layer and GaAs/AlAs epitaxial layers with the feature size less than 100nm. As for aluminum layer, the resolution is better than 20 nm. Useful information such as EBSD, orientation mapping and band contrast mapping can be obtained. The transmission configuration will also result in better signal-to-noise ratio. Transmission EBSD exhibits great potential in the semiconductor industries.

Conclusion

References