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Microbeam analysis — Analytical electron microscopy — Method for the determination of interface position in the cross-sectional image of the layered materials

Analyse par microfaisceaux — Microscopie électronique analytique — Méthode de détermination de la position d'interface dans l'image de coupe transversale des matériaux en couches

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Foreword

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This document was prepared by Technical Committee ISO/TC 202, *Microbeam analysis*, Subcommittee SC 3, A*nalytical electron microscopy*.

Introduction

Multi-layered materials are widely used in the production of semiconductor devices, various kinds of sensors, coating films for optical element, new functional materials, etc. One of the factors used to determine the characteristics of multi-layered materials is the layer thickness, for evaluation of products and verification of the production process. In practice, measuring the total thickness and/or the thickness of each layer and checking the uniformity of thickness and/or flatness of the interface are often done using recorded images of the materials. Evaluations can be made from the cross-sectional TEM/STEM images by accurately determining the averaged interface position between two different layered materials.

In relation to the determination of the interface position in the HR atomic imaging, analysis by the multi-slice simulation (MSS) method can be applied for the target measurement, if the atomic structural models can be constructed. However, in real materials, there are a lot of cases when they cannot, as follows:

— the interface between amorphous layers, or layers of amorphous substance and crystal;

— the interface recorded in low-resolution image in which the atomic columns cannot be identified: 1) very thick single-layered material, 2) thick multi-layered material.

This document relates the method to determine the averaged interface position, using a differential processing of the accumulated intensity profile getting from the ROI set in the cross-sectional TEM/STEM image of the multi-layered materials. The thickness of the layer that can be applied ranges from a few nanometers to a few micrometers. Thus, this document is not intended for the determination of the simulated position of the layer interface analysed by the MSS method.

Microbeam analysis — Analytical electron microscopy — Method for the determination of interface position in the cross-sectional image of the layered materials

1 Scope

This document specifies a procedure for the determination of averaged interface position between two different layered materials recorded in the cross-sectional image of the multi-layered materials. It is not intended to determine the simulated interface of the multi-layered materials expected through the multi-slice simulation (MSS) method. This document is applicable to the cross-sectional images of the multi-layered materials recorded by using a transmission electron microscope (TEM) or a scanning transmission electron microscope (STEM) and the cross-sectional elemental mapping images by using an energy dispersive X-ray spectrometer (EDS) or an electron energy loss spectrometer (EELS). This document is also applicable to the digitized image recorded on an image sensor built into a digital camera, a digital memory set in the PC or an imaging plate and the digitalized image converted from an analogue image recorded on the photographic film by an image scanner.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1
atomic column image
TEM/STEM image recorded at atomic-resolution from a specimen along a high-symmetry crystalline orientation

Note 1 to entry: Crystalline orientation is the direction of crystal which is represented by Miller indices. During TEM imaging, it is often useful to have a crystalline specimen aligned so that a specific (low index) *zone axis* (3.1.26) is parallel, or near parallel, to the beam direction (optical axis).

3.1.2
cross-sectional image
TEM/STEM image of the multi-layered materials along a plane perpendicular to the stacking direction

3.1.3
differential processing
calculation of the difference between the values of adjacent pixel data in the intensity profile