ICS 71.040.50
CCS N33

NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

GB/T 43087-2023

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

微束分析 分析电子显微术 层状材料截面像中界面位置的确定方法

Issued on: September 7, 2023 **Implemented on: April 1, 2024**

Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC

Table of Contents

1 Scope 1
2 Normative reference documents 1
3 Terms, definitions and symbols 1
3.1 Terms and definitions 1
3.2 Symbol 3
4 Preparation of cross-section specimens 3
4.1 General 3
4.2 Requirements for cross-section samples 4
5 Determination of interface location 4
5.1 Overview 4
5.2 Preparation 4
6 Interface position determination step 6
6.1 Overview 6
6.2 Obtaining cross-sectional TEM images/STEM images 8
6.3 ROI settings 9
6.4 Obtaining the mean intensity curve 14
6.5 Moving average processing 16
6.6 Differential processing 17
6.7 Determination of interface location 17
7 Uncertainty 18
36 Reference 37

Foreword

This document complies with the provisions of GB/T 1.1-2020 "Standardization Work Guidelines Part

1.Structure and Drafting Rules of Standardization Documents" Drafting. This document is modified using ISO 20263.2017 "Microbeam analysis - Determination of interface position in cross-sectional images of layered materials using electron microscopy" method". The technical differences between this document and ISO 20263.2017 and their reasons are as follows:

---Changed the ordinates of Figure 10c), Figure 11 and Figure 12a) (see 6.4, 6.5, 6.6) to increase operability and facilitate the application of this document;

---Changed the expression of the number of measurements, the expression formula of the total data set and the expression of formula (9) (see 7.1) to improve the accuracy of calculations to facilitate the application of this document;

---Changed the length of R in Figure A.6 (see A.3.1) to improve the accuracy of the data;

---Changed the pixel value of S6 in Figure A.18 to 1779pix (see A.4.5) to increase operability and facilitate the application of this document. The following editorial changes have been made to this document.

---Added range notes (see Chapter 1) to improve the operability of the method of determining the interface location;

---Deleted terms that are not used or used only once (see 3.1);

---Replace ISO 29301.2010 with the informative GB/T 34002-2017 (see 3.1.3, 3.1.6, 3.1.10, 3.1.14, 6.2.1, 7.2, references);

--- Added a note on the term multi-layer simulation method, and gave another name for the multi-layer simulation method, multi-chip method (see 3.1.12);

---Changed the expression of EDS and EDX definitions (see 3.2);

---Added the abbreviations RM and CRM (see 3.2);

---Added a note on determining the interface position (see 6.7), explaining that the selected cross-sectional image range and the quality of the cross-sectional image determine the interface position. Important reference;

---Deleted the interface position sequence (see Appendix A) and changed it to as shown in Figure A.5, Figure A.10, and Figure A.18 respectively. (See A.2.5, A.3.5, A.4.6). Please note that some content in this document may be subject to patents. The publisher of this document assumes no responsibility for identifying patents. This document is proposed and coordinated by the National Microbeam Analysis Standardization Technical Committee (SAC/TC38). This document was drafted by: University of Science and Technology Beijing. The main drafters of this document. Quan Maohua and Liu Delu.

1 Scope

GB/T 43087-2023 gives the method for locating an interface in the cross-sectional electron microscope image of a layered material. It answers a question that looks trivial and is not: in a TEM or STEM image of a stack of thin films, the boundary between two layers is not a line but a gradient several nanometres wide, produced by real interdiffusion and by the projection of a specimen that has thickness, and where one places the interface determines every layer thickness measured from that image - which is how gate oxides, barrier layers and coatings are specified. The standard sets the preparation of the cross-section specimen and its requirements, then the determination of the interface position step by

step: acquiring the image, setting the region of interest, obtaining the mean intensity curve, the moving average processing and the criterion applied to it, with annexes on measuring layer thickness and calibrating image magnification. It took effect on 1 April 2024.

This document specifies a method for the determination of the average interface position between two different materials recorded using cross-sectional images of layered materials. This document is applicable to cross-sectional images of layered materials recorded by transmission electron microscopy (TEM) or scanning transmission electron microscopy (STEM). and the cross-sectional element surface distribution map recorded by X-ray energy spectrometer (EDS) or electron energy loss spectrometer (EELS). Also suitable for digital The digital image collected by the camera, computer memory and imaging board image sensor, and the analog image recorded on the film are converted into a digital image by the scanner. This document does not apply to the determination of interface positions obtained by the multilayer simulation method (MSS).

Note. When the contrast difference on both sides of the interface in the TEM image/STEM image is small, it will cause the pixel intensity to oscillate violently, and the noise generated will affect the average interface position. judgment.

2 Normative reference documents

This document has no normative references.

3 Terms, definitions and symbols

3.1 Terms and definitions The following terms and definitions apply to this document.

3.1.1 cross-sectionalimage cross-sectionalimage TEM image/STEM image of multi-layer materials along the direction perpendicular to the stacking direction.

3.1.2 Calculates the difference between adjacent pixel data in an intensity distribution plot.

3.1.3 digital cameradigitalcamera By chip array image sensors [such as charge coupled device (CCD) or complementary metal oxide semiconductor (CMOS) sensors, see 3.17] A device that converts visual images into electrical signals. [Source:

GB/T 34002-2017, 3.8, with modifications]

3.1.4 An image generated from the signal of a selected specific element on an EDS/EELS spectrum.

3.1.5 filtering mask filteringmask Mask defining the cutoff frequency in reciprocal space.