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Surface chemical analysis — Proposed procedure for certifying the retained areic dose in a working reference material produced by ion implantation

Analyse chimique des surfaces — Mode opératoire proposé pour certifier la dose aréique retenue dans un matériau de référence de travail produit par implantation d'ions

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Foreword

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Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 16268 was prepared by Technical Committee ISO/TC 201, *Surface chemical analysis*, Subcommittee SC 2, *General procedures*.

Introduction

This Technical Report brings together experience to provide a proposed procedure, untested as a full procedure, to address the general problem of how to obtain a certified working reference material (WoRM) for the quantitative surface chemical analysis of a given solid material available in wafer (disc) form. The WoRM discussed here is essentially an ion-implanted wafer, where the virgin wafer — chosen or prepared by the analyst — has been ion-implanted with, typically, one isotope of a chemical element (henceforth referred to as the analyte) of an atomic number larger than that of silicon. This WoRM is certified by the proposed procedure for the areic dose of the analyte retained.

The retained areic dose of the ion-implanted analyte in the WoRM wafer is certified by comparative measurement against the retained areic dose of the same analyte in an ion-implanted silicon wafer having the status of a (preferably certified) secondary reference material (SeRM). The comparative measurement is performed in a two-step process in which an intermediary third reference material and two measurement techniques [wavelength-dispersive X-ray fluorescence spectrometry (WD/XFS) and ion-implantation dosimetry] are used. The intermediary reference material, referred to as a transfer reference material (TrRM), is also an ion-implanted silicon wafer and is a (non-identical) implantation twin of the WoRM (i.e. it is co-produced with the WoRM but differs in wafer type and retained areic dose). Its function is, firstly, to avoid possible secondary-excitation effects in a direct WD/XFS measurement on the WoRM and, secondly, to allow the WoRM to be certified also for retained areic dose levels far below the measuring range of WD/XFS.

This certification of the WoRM is part of a new concept and procedure for characterization of reference materials. In this concept, the WoRM, TrRM and SeRM have their places in a chain of reference materials and a sequence of certifications. The SeRM is at the interface between the area of responsibility of the analyst and that of a commercial supplier of reference materials. This Technical Report describes the part of the procedure within the area of responsibility of the analyst and is based on the assumption that a suitable SeRM is obtainable. When an SeRM is available, the analyst must also have access to a suitable ion implanter and to a suitable wavelength-dispersive X-ray fluorescence spectrometer for comparative measurement of retained areic doses.

The wafer format requirement of the WoRMs implies a particular suitability for the analysis of semiconductor materials, although it is by no means restricted to this application. A restriction exists, however, in the choice of surface-analytical technique. Although specimen and WoRM may be identical in analyte and host matrix, the analyte may be present in a different chemical state and a different depth distribution. Meaningful results from referencing to the WoRM can then be obtained only if the chosen surface-analytical technique is insensitive to the chemical state of the analyte and if the technique allows corrections for different depth distributions. This problem is addressed with special reference to analysis by secondary-ion mass spectrometry. With an appropriate choice of surface-analytical technique, the WoRMs can be used for quantitative measurement of homogeneous, ion-implanted, diffused and layered depth distributions of the analyte.

This Technical Report is essentially based on Reference [1]. This work has also been a project (Technical Working Area 2/Project 5) within the international Versailles Project on Advanced Materials and Standards (VAMAS)[2].