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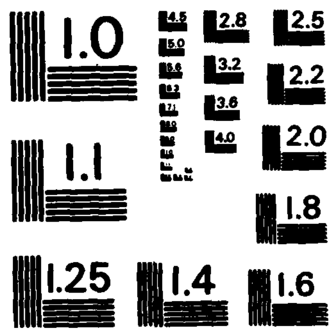

MICROCOPY RESOLUTION TEST CHART
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This study of factors that influence image quality in the ion microscope will motivate modification of the existing configuration in order to improve the lateral resolution and the absolute sensitivity. The micro-test patterns provide an absolute scale of image evaluation and thus are used to characterize the imaging capabilities of the SIMS analyzer. The efforts anticipate the decreasing dimensions of the next generation of submicron structures.

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ABSTRACT

This study of factors that influence image quality in the ion microscope will motivate modification of the existing configuration in order to improve the lateral resolution and the absolute sensitivity. The micro-test patterns provide an absolute scale of image evaluation and thus are used to characterize the imaging capabilities of the SIMS analyzer. The efforts anticipate the decreasing dimensions of the next generation of submicron structures.

Introduction

The imaging mode of a stigmatic SIMS microanalyzer such as the CAMECA IMS-3f provides the unique capability of producing a magnified localized mapping of the elemental constituents on a sample surface in real time. The principle function of the instrument when used in the microscope mode is to resolve detail present in the specimen. Magnification is necessary to make the image of sufficient size so that the smallest microfeatures resolved by the instrument can be seen by the eye. Therefore it is convenient to compare instrumental parameters of the ion microscope in terms of its inherent resolution capabilities.

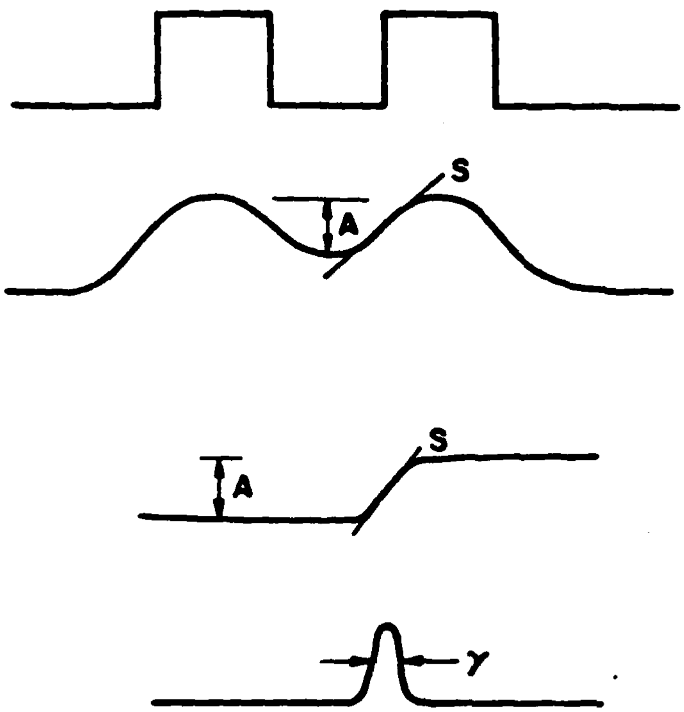
The lateral resolution obtained with the CAMECA instrument is generally quoted anywhere between 0.3 - 1.0 μm. A critical evaluation of such a range becomes essential before attempting to extract information from the ion image. An accurate knowledge of the spatial resolution and the factors that influence it defines the scope of microfeature recognition as is necessary prior to image processing techniques.

Criterion for Image Resolution

Standard test patterns were fabricated using electron beam lithography/ metallic evaporation and mark removal techniques in the form of even square waves (or simple step function standards). These were imaged on the CAMECA IMS-3f stigmatic SIMS microanalyzer; the images being digitized on a micro-photodensitometer afterwards. These digitized images were analyzed and yielded signal traces of the square wave pattern that were gaussian in nature.

These intensity profiles (graphically illustrated in Fig. 1) have a characteristic slope and amplitude typical to the imaging instrument with the instrumental parameters used. The slope and amplitude are isolated in an edge profile (or edge spread function of the instrument) which is deconvalued to yield the line spread function of the instrument. It can be shown that by measuring the width of this curve at the inflection points a quantitative measure of the spatial resolution of the imaging instrument is achieved. *

SIMS SPATIAL RESOLUTION METHODOLOGY



STEP FUNCTION STANDARD

RESULTING SIGNAL TRACE

[AMPLITUDE (A) → CONTRAST
SLOPE (S) → RESOLUTION]

EDGE SPREAD FUNCTION (ESF)
FROM SLOPE

DECONVOLUTE ESF TO
LINE SPREAD FUNCTION (LSF)

[AT INFLECTION POINTS OF LSF IS
SPATIAL MEASURE OF RESOLUTION]

Resolution Evaluation

Results indicate that the character of the sample (i.e. resistivity, surface texture, etc.) and the instrumental operating conditions (vacuum, contrast aperture setting, instrumental field of view, magnification factor, and microchannelplate gain) directly affect the relative resolution of the ion image. The best image resolution of 0.53 ± 0.03 µm. was achieved using the 150 µm. field of view with the highest magnification (250X as measured at the fluorescent screen), the smallest contrast aperture (20 µm.) and an operating vacuum of 10^{-7} torr.

* The associated proof is illustrated in detail in the paper which will be published January 1986, in ANALYTICAL CHEMISTRY.

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