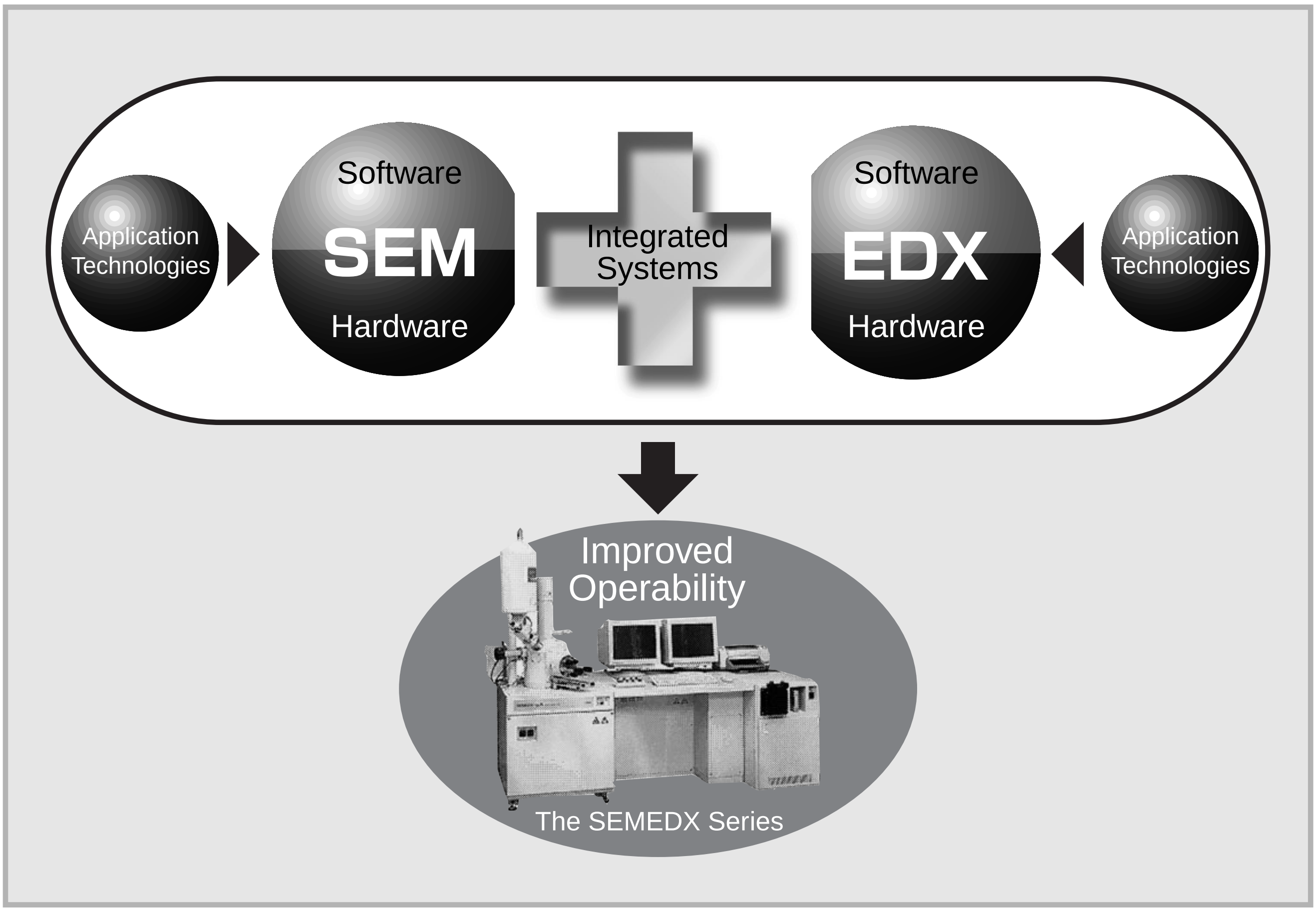
FEATURE ARTICLE

SEM/EDX-Integrated Analysis System SEMEDX Series

Toshikazu YURUGI, Sukehiro ITO*, Yoshinori NUMATA*, Keith SYKES**

*Hitachi Science Systems, Ltd., **Oxford Instruments plc.



Abstract

In the laboratories today, a scanning electron microscope (SEM) is nearly always used in combination with an energy dispersive X-ray analyzer (EDX). In the past, when functionally independent SEM and EDX were combined for analysis, equipment operation was complex and the operator had to master the different operations for each instrument. Horiba, Ltd., Hitachi, Ltd., and Oxford Instruments, plc have joined together, each utilizing their own areas of technical expertise, to create the SEMEDX Series of SEM/EDX-integrated analysis systems, which have been designed so that any operator can achieve simple operation, fast, clear SEM observation, and accurate EDX analysis. In this paper I shall introduce the various feature functions of the SEMEDX.

1 The Background behind SEMEDX Development

With the lowering costs of scanning electron microscopes (SEM) in recent years, the SEM has moved beyond a specialized market centered around experts at research centers, universities, analysis centers, etc., to a wide range of applications that include high schools and the quality control divisions of many industries. Also, with the growing need to understand the composition and distribution of elements in addition to observing sample material shape, it is now common for businesses and organizations to introduce energy dispersive X-ray analyzers (EDX) at the same time an SEM is purchased. At present, more than half of the newly purchased SEMs come with a built-in EDX.

SEM and EDX devices have conventionally been designed for use by analytical technology specialists. However, with today's rapidly expanding SEM/EDX market, there is a growing need to improve the functionality of these devices so that they can also be used easily by engineers working in quality control and R&D.

Also, with the advancements made in the electronics field, SEM/EDX operation has changed primarily from analog to digital operation, with the equipment controls and data processing being handled by computer. Generally, a Windows™ operating system and Windows applications are used, creating a system environment that nearly anyone can operate easily.

Based on today's market needs and changes in peripheral technologies, the SEMEDX is an analysis system that combines SEM and EDX into one unit designed on the product development concept of allowing anyone to achieve fast, clear SEM observation and accurate EDX element analysis using easy operations.

2 System Configuration and Functions

With conventional systems, a stand-alone EDX is combined with a separate SEM, so the operator has to learn how to use both systems, and each system must be operated separately. With the SEMEDX, the SEM and EDX are combined into one unit, greatly reducing the need for complex operations.

2.1 System configuration

The SEMEDX is based on the Hitachi S-3000 scanning electron microscope. The functions of an SEM and EDX are combined into one unit, so the SEMEDX configuration can be roughly divided into the SEM unit and EDX unit. The SEM unit contains the EDX detector, and the operation panel consists of two monitors, a keyboard and a mouse. The EDX control circuitry, two computers and MO disk drive are housed in a compact rack located next to the operating panel. Fig.1 shows the exterior of the SEMEDX III and Fig.2 shows the system configuration.

Fig.1 The SEMEDX III Integrated System

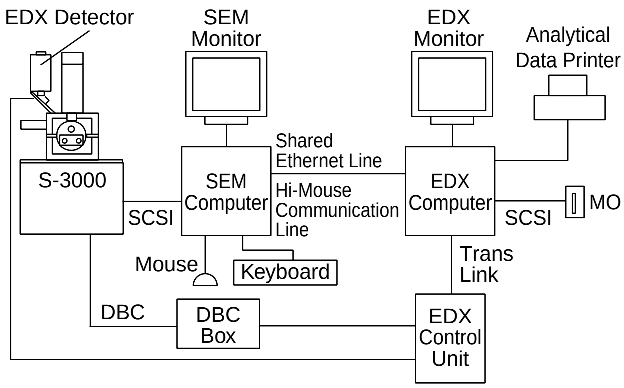


Fig.2 SEMEDX III System Configuration

To seamlessly merge the SEM and EDX functions in the SEMEDX, the computers for each unit are connected by an Ethernet for data sharing, and Hi-Mouse software developed by Hitachi provides easy operability. With the Ethernet and Hi-Mouse software, one keyboard, one mouse, and the two monitors can be used to smoothly operate the functions of both the SEM and EDX.

The user interface on the SEM unit has a dedicated EDX window that can be used to control the EDX unit. Windows folders can also be set to "shared", allowing data to be shared between the two computers. Work operations can be further simplified, and images viewed more easily, by setting one of the monitors to display observation images and the other to display analytical data.

2.2 The SEM unit

The easy-to-use S-3000 graphical user interface (GUI) is used in the SEM, allowing the SEM to be operated in the same way as a typical office computer. Operability is further improved with the SEMEDX by an arrangement of large tool buttons organized by application on the main operation screen. Printing functions for image data output have also been added that can be used to create reports while previewing printout and layout images. The optional full-screen display function can also be used to view sharp, highly-detailed SEM images.

SEM unit maintenance has also been simplified with the inclusion of animated computer graphics maintenance guides. These guides walk the user through even the most complex maintenance operations. The main unit has an electronic optical system that ensures the highest level of resolution in this class of equipment, making it possible to perform hi-resolution observation of samples. An extensive range of optional application software is also available, allowing new functions to be added as required for the analysis objectives.

2.3 EDX unit

The EDX unit incorporates an abundant range of functions that were created through an alliance with Oxford Instruments, plc.

The primary feature of the EDX is a flow chart format navigator function for controlling the analysis procedure. With this function, all operations, from measurement preparation to report drafting, can be executed smoothly in accordance with the displayed flow chart. The software also provides bubble help and hints, allowing the operator to call up detailed instructions and explanations using only the buttons displayed on the screen, thereby eliminating the need to constantly reference bulky instruction manuals. This is one of the primary features of the EDX, which has been designed to provide improved operability, and these new features greatly contribute to increased analytical work efficiency. Fig.3 shows the navigator screen and Fig.4 shows various examples of bubble help displays.

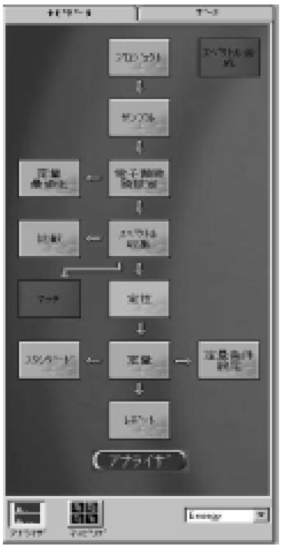


Fig.3 Analyzer Navigator

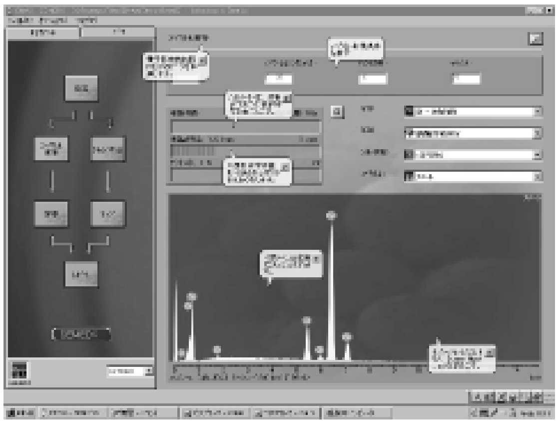


Fig.4 SEMEDX Bubble Help

The function that provides the strongest support for element distribution analysis is Smart Map. This function records the X-ray spectral data for all analysis points on the test sample together with the positions of analysis, allowing the user to recall specific data as needed. With conventional systems, the elements to be observed had to be preset before mapping, so if additional elements were to be measured, mapping had to be performed again. With Smart Map, however, measurement only needs to be performed one time. The saved data can be repeatedly recalled for additional analysis, processing and display, greatly increasing the productivity of analytical work.

A wide range of other application software developed for the EMAX Series can also be added for specific applications, including software phase analysis that can extract areas of a sample that have the same composition, "Cameo$^+$", which creates visual displays of the conditions of compositional distribution, and applications for searching the spectral data stored in the EDX.

3 Feature Functions of the SEMEDX

The SEMEDX has been designed to allow smooth, easy operation of SEM image observation functions as well as easy EDX element analysis setup and execution. Also, in order to provide more accurate, rapid analysis, a recipe function has been added that makes it possible to simultaneously set and save optimum analysis conditions for both SEM and EDX parameters.

With conventional systems, the SEM and EDX are independent units. First, a sample is observed as an SEM image under optimal conditions for the SEM, and then the test sample position is repeatedly adjusted between the SEM and EDX to achieve maximum X-ray detection efficiency during EDX analysis. This type of analysis truly involves many bothersome operations. With the SEMEDX, however, the operator simply selects a recipe that corresponds to the properties of the sample, specifies the area of the sample to be analyzed with the SEM image, and presses the "Start Measurement" button. EDX analysis is performed automatically and the measurement results are displayed on the SEM monitor. In other words, all operations, including EDX measurement, can be controlled from the SEM side. The same procedure can be used to perform element distribution measurement (mapping) for the entire SEM observation area. Fig.5 shows the flow of SEMEDX analysis operation.

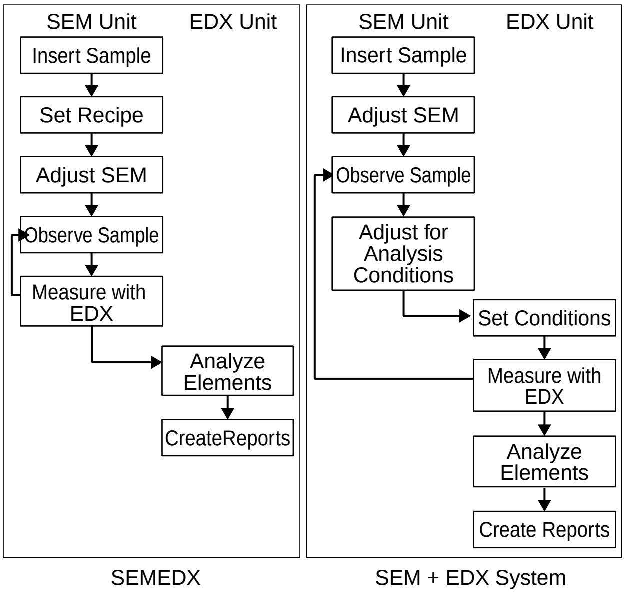


Fig.5 SEMEDX Analysis Flow

The operations for creating reports of the analysis data and for saving the data are handled by the EDX unit. The SEMEDX is a fully integrated system that handles everything from analysis start up to measurement result output and storage.

The following list summarizes the functions that contribute to the outstanding operability of the SEMEDX.

(1) A recipe function is used to simultaneously set, save, and recall the analysis parameters for the SEM and EDX.

(2) EDX measurement conditions can be set from the SEM unit (Fig.6).
(Spectral measurement, multi-point measurement, mapping, display of analyzed elements on the SEM monitor)

(3) Image data obtained with the SEM can be used as basic data for the EDX.

(4) Setting conditions for the SEM unit are automatically transferred to the EDX unit.

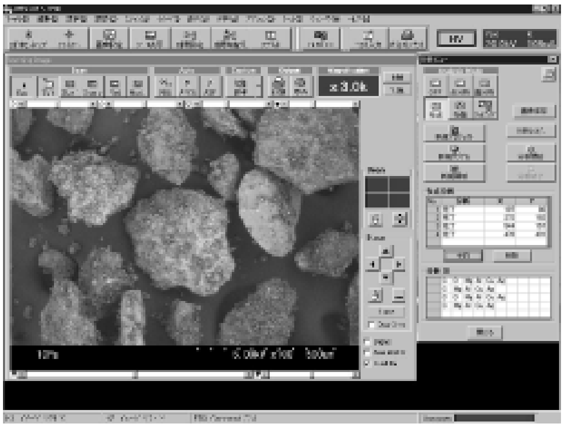


Fig.6 EDX Analysis Window Displayed on the SEM Monitor

4 Summary

This concludes our introduction of the SEMEDX system configuration and feature functions.

The SEMEDX is not simply an independent SEM and independent EDX housed together in one cabinet; it is an excellent example of the fusion of various device functions into one unit to create a whole that is greater than the sum of its parts. In particular, by creating a system that can share the individual functions of each unit, the SEMEDX provides the outstanding advantage of freeing the operator from the bothersome duty of operating the SEM and EDX separately, which in turn makes it possible for the SEMEDX to be operated easily by a wide range of users.

This has all been made possible by the many years of cooperation between Hitachi, with its electron microscope technologies, and Horiba, with its energy dispersive X-ray micro analyzer technologies, and the new inclusion of application technologies from Oxford Instruments, plc, of course, played no small part in the success of SEMEDX development. This is truly an excellent example of the successful results of a global alliance.

Now, at the start of this new century, there is no doubt that we will see even greater advancements in IT related technologies, including computer and Internet technologies. In order to maximize the possibilities for SEMEDX functions, the system must of course provide excellent operability for the analytical equipment itself, but it is also vital to further enhance application technologies and accumulate new expertise in the area of applications.

In that respect, we feel that the application of the newly developed recipe functions is very important to SEMEDX development. This concept could be carried further, by adding links to the manufacturers' home pages to allow the manufacturers to provide analytical data and know-how. Such features would make it possible for the manufacturers to provide the user with a system environment that would allow highly accurate analysis to be performed even more easily.

We hope that the SEMEDX will become an impetus for an even closer exchange of information between the manufacturers and users.

Toshikazu YURUGI

Scientific Instruments R&D Dept.

Horiba, Ltd.

Sukehiro ITO

Hitachi Science Systems, Ltd.

Yoshinori NUMATA

Hitachi Science Systems, Ltd.

Keith SYKES

Oxford Instruments plc.