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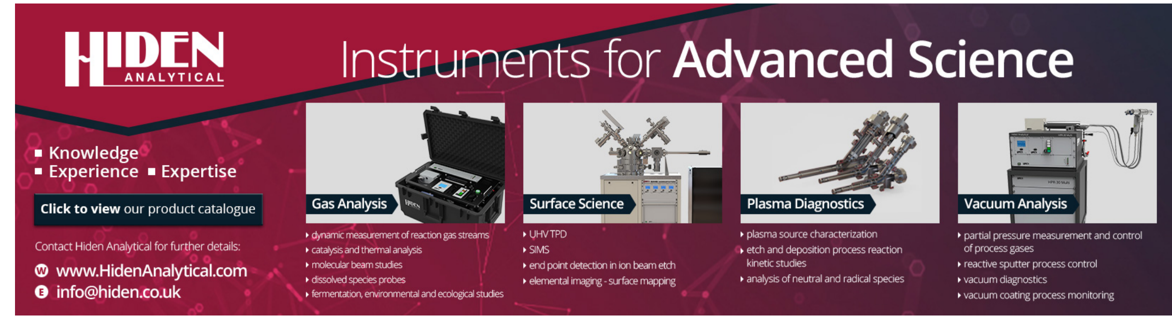

# Summary Abstract: Computerized scanning Auger microprobe

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Auger spectroscopy can yield a wealth of information about the surface of a sample.[1] Most of the spectrometers built in the seventies are able to collect reasonably good Auger data, but they require both a spectrometer operator to continuously monitor and control each stage of the data taking process and a skilled analyst to laboriously carry out the intensity determinations and other computations by hand. Now in the eighties, when microcomputers have become readily available and relatively cheap, it is desirable to have them carry out most of both the control and analysis functions. This presentation shows how a spectrometer (a Physical Electronics Industries model 545 scanning Auger microprobe[2]) can be controlled by a microcomputer (a Southwest Technical Products 6809 Computer System[3]) which uses a 6809 microprocessor. The computerized system is fully automated so that it takes spectral data, performs data taking/sputtering sequences during depth profiling, and takes elemental contour maps and roving spot analyses.

The design of the computerized system was based on several fundamental criteria: (1) Straightforward and dependable operation of the system so that keyboard control of the spectrometer is easier than manual control, even for an operator without computer experience. (2) Automated depth profiling so that hours of unattended ion milling become possible. (3) Automated excitation beam control so that various spots and element contour maps of the surface can be monitored. (4) Software written in a simple language so that minor or major changes can be easily implemented. (5) Convenient and semipermanent data storage so that detailed analysis becomes possible. (6) Many computer peripherals to enable a variety of data display modes. (7) Low total capital cost ($\approx$ \$4000).

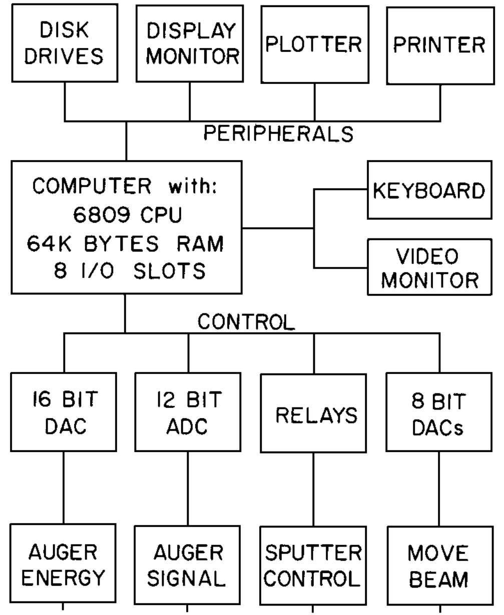


FIG. 1. Schematic of the 6809 computer which emphasizes its interfacing structure to both the peripherals and the spectrometer.

Figure 1 shows the computer mainframe and its I/O connections. Data can be output to a variety of peripherals as shown in the top two-thirds of the figure. Four special boards were required for the computer to control the spectrometer as shown in the bottom of the figure. These boards are: (1) Auger energy control board, which sets the Auger detection energy with its 16-bit digital-to-analog converter (DAC); (2) read Auger signal board, which reads the Auger signal intensity with its 14-bit analog-to-digital converter; (3) multipurpose DAC board, which uses two pairs of 8-bit DAC's to position the excitation beam and display the data in memory on the CRT display monitor; and (4) timing and relay control board, which switches various power supplies on and off as needed during the fully automated data taking/sputtering sequences.

For ease of future upgrades and users, all programs are written in a 16K BASIC, except for three subroutines written in machine language since BASIC routines were too slow or inadequate. These three routines are: (1) SCAN, the Auger energy ramp routine which rapidly ($\sim 100\ \mu s$) increments the energy and is used for most of the data taking; (2) DISPLAY, the routine which displays the spectrum on the CRT monitor; and (3) PROFILE, the routine which controls the off/on interrupt timing required when data are taken after various time elapsed sputter intervals during the automated depth profiling sequence.

The main Auger control program has a number of special features. It is entirely driven from menus so that the operator always knows what processes are available for selection or is aware of what process is on-going. It can be used in a select single operation mode or in an automatic mode, in which spectral scan data are taken after any number of operator selected elasped sputter times without the operator being present. The program permits many operations to be performed during the sputter process. This includes storage of data on disk, data plotting, and data display on the SAM's CRT monitor with expansion and manipulations possible. In addition, the program has been fully error trapped so that operator errors are handled in a nonfatal manner.

Examples will be given of the various forms in which the data can be displayed on either the digital plotter or the CRT display monitor. The software developed for this type of output will also be discussed.

[1]A. W. Czanderna, *Methods of Surface Analysis* (Elsevier, Amsterdam, 1975), and other review references contained therein.
[2]Southwest Technical Products, 219 W. Rhapsody, San Antonio, TX 78216.
[3]Motorola Semiconductors, 3501 Ed Bluestein Blvd., Austin, TX 78721.

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