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PC-Based Digital Imaging for Storing Microscopy Images for Surveillance Programs

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INTRODUCTION

Advances in video technology and digital imaging have resulted in the ability to produce an image in high quality digital format. Images that are created and viewed in a digital format can be quantitatively measured and then stored to disk for later examination. Write-once read many (WORM) optical disks are excellent media for permanently archiving digital images. One of the best applications for this image storage technology is storage of microscopy images for surveillance programs.

Currently, the most common type of recording medium used in service laboratories is Polaroid instant developing film. The short developing time and ease in processing make it well suited for most high volume laboratories. But the convenience of this film has a substantial price tag. Depending on the type of film, each picture can cost about $1.50. The two metallurgical support laboratories at Mound are frequently required to make multiple copies for design agencies or program managers. Permanent archiving of photos is required for both WR and surveillance samples. This has made Polaroid film a significant part of the expense budget. In addition, the thousands of photos taken annually present a considerable storage problem.

The extensive use of Polaroid instant film in Mound Metallurgy labs prompted the development of a digital image storage capability based on the personal computer (PC). By applying PC-based digital technology, images examined on many different types of microscopes can be digitally stored to disk. This ability is being used to store, retrieve, and process images on optical metallographs, specialized microscopes, and scanning electron microscopes (SEM).

SYSTEM CONFIGURATION

Four separate image storage systems are in use at Mound. One for optical metallographs, two for SEMs, and one for a video intensified microscope (VIM). The basic hardware design for each system is the same. The difference is the input sources and the requirements for connecting the systems to these sources. The acquisition system is shown in Figure 1.

Each digital storage system is built around a Compaq 386 PC. An Imaging Technologies PCVision Plus digitizing board is installed in each computer. This board has a resolution of 640 by 480 pixels with 256 gray levels. A separate monitor connected to the digitizing board displays the image. A photo replay unit allows "hard copy" Polaroid pictures to be made from stored images as required.

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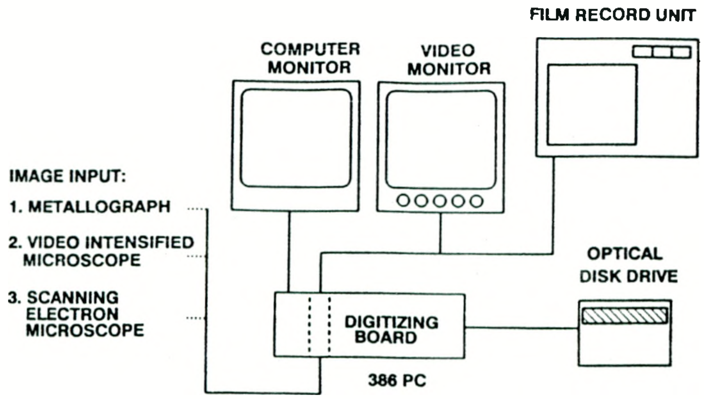

Figure 1 - Image storage system.

STORAGE MEDIA

Several options exist for storing digital images. These include magnetic floppy disks, fixed and removable hard disks, magnetic tape, and optical disks. All the magnetic media have significant drawbacks. The digitized images occupy 307 kbytes of storage space. This limits high-density floppy disk storage to four images per disk. Fixed hard drives have a much greater storage capability. A 300-Mbyte drive can store about 1000 images. However, in a high volume this would be filled within months. Removable hard drives are not cost effective. Magnetic tape is inexpensive, but slow and cumbersome to use on a PC.

The WORM optical disk technology provides the best option for cost-effective, fast data storage. Depending on the manufacturer and model, the 5-1/4 in. disks can store from 230 Mbytes to 1.2 Gbytes of data per disk. The disks in use at Mound are the 5-1/4 in., 230 Mbytes size. This allows us to store 700 images per disk at a cost of $0.23 per image. If the more expensive 1.2 Gbytes disk were used, more than 4000 images could be stored at a cost of $0.07 per image.

Optical disks are well suited for archival storage of surveillance images. They can be stored in a fraction of the space needed to store the equivalent number of photographs, and the WORM technology provides a natural safeguard against accidental erasure and loss of data because the disks are not susceptible to data loss from magnetic fields.

APPLICATIONS

Metallograph

The metallograph was interfaced with the image system by connecting a video camera to a camera port on the microscope. The camera's RS-170 output was connected directly to the digitizing board in the computer. An example of an image retrieved from the image acquisition system is presented in Figure 2.

Image enhancement is another advantage of digital imaging. Background subtraction, edge enhancement, and image sharpening are useful routines for metallurgical evaluations. Also, quantitative microstructural measurements can be done through image analysis, including determining grain size, amounts of ferrite or austenite, plating thickness, and particle size.

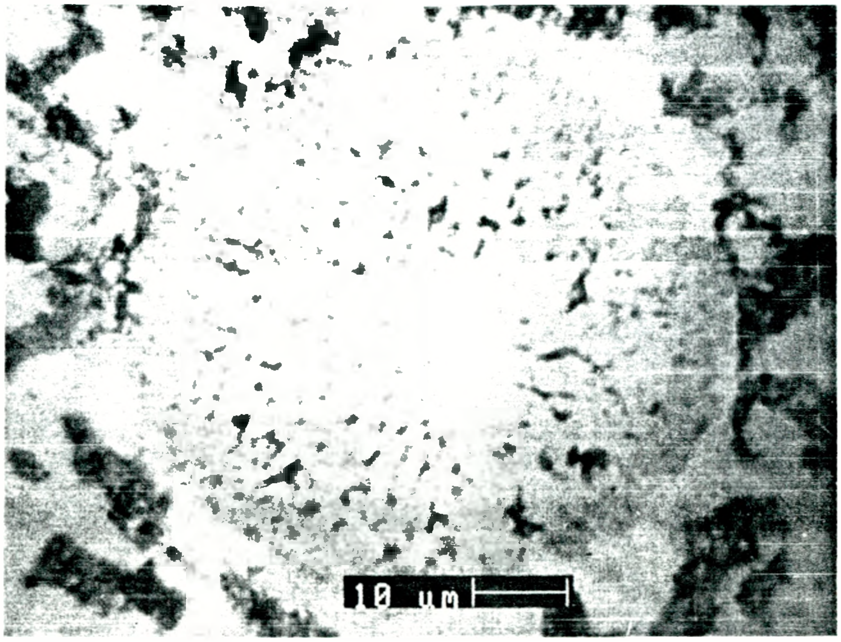

Figure 2 - Polished cross section of a gold bridgewire showing the lead-tin-indium reaction zone.

Scanning Electron Microscope

The SEM's slow scan analog video signal is translated to a digital signal by an analog to digital (A/D) board in the computer. As the primary photograph is being taken, the archived copy is being acquired simultaneously and stored at the completion of the image acquisition. The amount of time required to digitize the image depends on the record rate of the SEM. This rate varies from 16 to 100 seconds. Generally, an image that is acquired for longer periods of time has better resolution on SEM images. Longer acquisition times allow the computer to average several points for each pixel stored in the digitizing board. By averaging several points for each pixel, the random noise from the SEM can be reduced, yielding a less grainy image.

SUMMARY

The economical digital image storage systems constructed at Mound have been successful in storing quality images. The input comes from a variety of sources and is stored onto optical disks. These images can be stored in less space than conventional film and at a lower cost.

Several areas are being examined for future applications of digital image storage. Typically, copies of our photographs are sent to various design agencies. One solution to sending photographs would be to send digitized images to these locations and let these sites examine the images on similar systems at their locations. Images could be sent by optical disk or removable hard disk. This would allow design agency personnel to select and make "hard copies" of the images that are most pertinent to an investigation. As the communications network among sites increases in capability, the images could also be sent via telecommunications.