MODERN MICROSCOPY ON THE LIGHT SIDE
An Instrumental Approach to Small Particle Identification

Dr. John Gavrilovic, McCrone Associates, Inc.

Developments in space exploration, microelectronics, and other high-tech industries have promoted cleanroom technology and increased the need to identify particles sometimes too small to handle with the polarizing light microscope. Light microscopy has traditionally been the most commonly used technique for small particle identification and many microscopists are very proficient in identifying particles using a polarizing light microscope as the principal investigative tool. The polarizing light microscope, in the hands of a good microscopist, is an extremely efficient instrument for particles down to a few micrometers in size. However, in the size range below 5 μm, an instrumental approach to small particle identification is essential.

The development of electron microbeam instruments in the early '60s and '70s introduced a new dimension to small particle identification. In these instruments, particles of 1 μm and smaller can be chemically identified when chemical characterization of particles is combined with cathodoluminesence and a relatively simple optical characterization in the instrument itself.

The introduction of new, fast, and efficient EDX x-ray detectors has improved the speed and efficiency of instrumental particle identification. Today, even a skilled light microscopist may request chemical information on particles which would, in the past, have commonly been identified by light microscopy. This is frequently the case for transparent and birefringent particles of several tens of micrometers. These types of particles comprise a major proportion of dusts. They are found in various electronic compounds, cosmetic products, sophisticated guidance devices, all types of switches and relays, pharmaceuticals, food products, and other such silicate-type particles that are so common we are addressing them as the "new" mineral species "cruddite." They are normally identified by polarizing light microscopy following an elaborate procedure which can take considerably longer than the 50-second analysis time of an electron probe or scanning electron microscope.

The electron microprobe is the instrument of choice for the identification of very small particles as it combines an analytical instrument with a moderately good quality light microscope equipped with incident light and darkfield illumination. It has high quality x-ray detectors covering all elements, except hydrogen, helium, and lithium. In most small particles, all major and minor elements can be identified in 20 to 30 seconds.

At this point, a light microscopist might ask, "How can an x-ray spectrum be used to identify a majority of small particles, when all known contaminants are composed of only 92 chemical elements?" To understand how small particles can efficiently be identified with instrumental chemical techniques, we must look into the process of identification by polarizing light microscopy. It is a common fact that the human brain has an extremely large, efficient image memory. We can recognize the faces of a large number of people. We also recognize and identify an incredibly large number of objects from everyday life. The principal method for memorizing such a large number of items is seeing them a few times and preserving their images in our almost unlimited memory. An experienced light microscopist has developed a remarkably large memory capacity for images of small particles, recognizing them by color, morphological characteristics, and a few simple microscopical tests. Therefore, he is skilled and efficient in particle identification.

During the x-ray analysis of unknown particles, we obtain an x-ray spectrum and very elementary microscopical information such as color, morphology and cathodoluminesence. After analysing thousands of small

(Continued on next page)

particles and deposits, an operator develops special skills resembling those of an experienced light microscopist. In 50 to 60 seconds, an experienced instrument analyst will recognize and identify a majority of small particles he sees. In addition, the instrumental approach will enable identification of many particles smaller than 0.5 μm. A unique aspect of chemical identification of small particles is that it takes only a few tenths of a second, regardless of particle size.

Other samples which can be identified with similar efficiency by instrumental techniques are very fine deposits, stains, and smudges on the larger samples. Organic deposits are usually identified only by supplying elemental chemistry. In many cases, even such limited information will help the light microscopist or organic chemist identify organic compounds.

An area of particle identification which has developed rapidly in the past 10 years is automated particle analysis. Instruments, such as the electron probe or scanning electron microscope, operate unattended under the control of a computer program for 10 to 20 hours, analyzing each particle of an unknown sample. A table of particle size distributions and complete chemistry for each size range can then be generated to characterize the unknown sample.

Notwithstanding some microscopists' claims, the fastest and most efficient way to characterize small particles is usually a combination of polarizing light microscopy and instrumental (electron microprobe) analysis. An experienced scientist with the skill to accurately interpret the data derived from his instrument is the key to the process. ■

Salesman's Quote of the Month:
"Of course we don't have as many servicemen as our competition. After all, our product is much more reliable."

Don's Advanced Guide To Medical Terminology

- ★ Artery - The study of paintings
- ★ Barium - What you do when CPR fails
- ★ Cesarean Section - A district in Rome
- ★ Colic - A sheep dog
- ★ Coma - A punctuation mark
- ★ Congenital - Friendly
- ★ Dilate - To live longer
- ★ Fester - Quicker
- ★ G.I. Series - Baseball games between teams of soldiers
- ★ Grippe - A suit case
- ★ Hangnail - On which to leave your coat
- ★ Medical Staff - A doctor's cane
- ★ Morbid - A higher offer
- ★ Nitrate - Lower than the day rate
- ★ Node - Was aware of
- ★ Outpatient - A person who has fainted
- ★ Post-operative - A letter carrier
- ★ Protein - In favor of young people
- ★ Secretion - Hiding anything
- ★ Tablet - A small table
- ★ Tumor - An extra pair
- ★ Urine - Opposite of you're out
- ★ Varicose Viens - Veins that are very near each other