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ON THE COVER

A model of the human ear, used at Northwestern University's Diagnostic Center for Hearing Impaired, was photographed partially assembled by James B. Lehman, NSC staff photographer. It calls attention to "Hearing Protection"—what the recent federal hearings on the proposed noise standard were all about. (See page 62.)

EDITORIAL STAFF

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Microscopical Identification Of Target Health Hazards

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Through sophisticated techniques and instruments, scientists can readily identify asbestos, lead, silica, cotton dust and other air-borne particulates in the workplace.

INDUSTRIAL HYGIENE is concerned with the study of hazards to the health of the industrial worker. Some of these hazards are tiny particles in the air we breathe. They are hard to trap and identify, and difficult to associate directly with the failure of health because many years may elapse after exposure before adverse effects occur.

In any case, we know we have problems. Focusing upon the need to create healthful working conditions, OSHA, in January, 1972, initiated the Target Health Hazards Program. The emphasis is on five hazardous workplace substances: asbestos, lead, silica, cotton dust, and carbon monoxide.

Asbestosis resulting from prolonged inhalation of respirable air-borne asbestos dust may appear 20, 30, or 40 years after the exposure. Other particulate hazards are cotton dust, lead compounds, and quartz. Unfortunately, air-borne particles of these materials are so ubiquitous that everyone from factory workers to housewives and school children is exposed to some extent.

Exposure to particulate lead compounds is common due to the use of tetraethyl lead in gasoline and in paint.

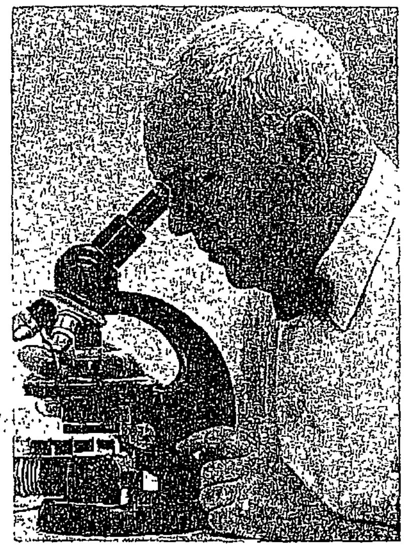
Asbestos is used in filters, insulation, fire-retardant textiles, and brake linings. Abrasion of these materials produces particles that find their way into the atmosphere.

Quartz, one form of which is silica, is the most common mineral on earth and few air samples are free of small particles of the type that may eventually cause silicosis.

Cotton dust, though less of a hazard than the others, is still a potent danger to industrial workers exposed for long periods of time to high cotton dust concentrations.

The exposure time to quartz and asbestos particles must be long-term, and the dosage high before serious impairment occurs. Our lungs also have a reasonably good flushing mechanism that helps to remove the billions of particles that settle every day on those surfaces. Perhaps this capacity for cleansing the lungs must be overwhelmed for some minimal time before permanent serious damage is done.

Many varieties of technical backgrounds must be involved before the solutions are found. The microscopist has one important role—



By **Walter C. McCrone,** D. Sc., Scientific Advisor, Walter C. McCrone Associates, Inc., Chicago.

among others—monitoring dust and other samples for the presence and amount of the hazardous substances. He is able to do this because the microscope magnifies each particle to a size such that selective

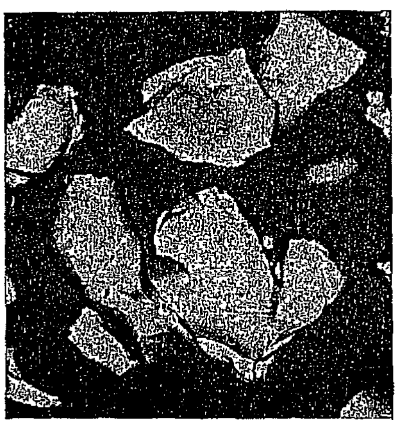


Figure 1 shows quartz (silica) particles magnified 125 times with crossed polars.

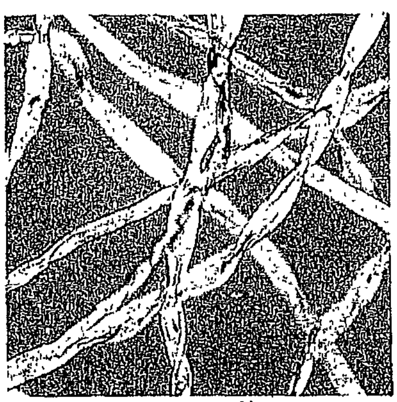


Figure 2 represents cotton fibers as they appear with crossed polars at 200 times magnification.

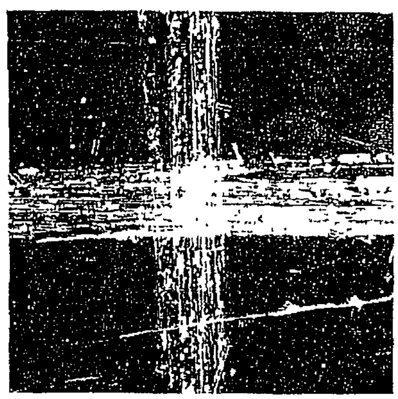


Figure 3 shows chrysotile fibers (one form of asbestos) at 100 times magnification.

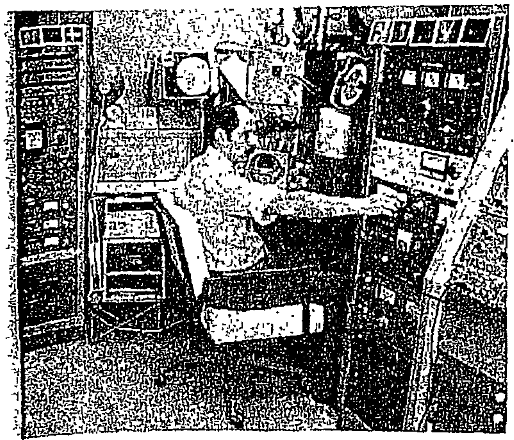


Figure 4 shows electron microprobe analyzer used at McCrone Associates.

Figure 5 shows the AEI EMMA 4 electron microscope/electron probe analyzer.

and specific physical measurements can be made to identify that particle. By selecting the proper microscope and utilizing his background in crystallography the microscopist can identify many particulate substances at sight. These include most of the air-borne particles detrimental to our health—quartz, cotton fiber dust, and asbestos. Lead is a special problem because there are many different lead compounds.

Carbon monoxide is not detectable by microscopy. Refer to the October 1973 NATIONAL SAFETY NEWS article "Target Health Hazard—Carbon Monoxide," for information regarding CO and the various means of detecting it.

First, consider the problem of identifying quartz microscopically. The shape and optical properties make this easy. Figure 1 shows quartz between two slightly uncrossed polarizing filters; the low birefringence (low numerical difference between the maximum and minimum refractive indices) and conchoidal (shell-like) fracture are obvious. To confirm his initial identification of quartz the microscopist has an optical staining procedure (called dispersion staining) that causes all quartz particles to appear blue or blue magenta. The latter procedure is excellent for detecting traces of very fine quartz in dust samples.

Next, consider cotton fibers. These, too, have characteristic optical properties and shape, and can be identified just as dependably as quartz (see Figure 2).

Asbestos presents a somewhat more complicated problem because asbestos is not a single substance, but a class of fibrous minerals of widely varying composition and properties. Even here, however, the microscopist is able to vary his procedure so that fibers observed microscopically can be further identified as chrysotile, antigorite, anthophyllite, tremolite, amosite, or crocidolite. Each has unique optical properties observed as optical staining colors when properly mounted for examination. Figure 3 shows one of four different asbestiform minerals, chrysotile. Again, individual small fibers can be identified even when present as trace quantities in a complex mixture.

Finally, we should consider lead compounds. As suggested, these present problems because they are not a specific compound as is quartz, nor even a small group of slightly different compounds like asbestos. There is, however, one simple procedure that identifies all lead-containing particles as such, though it does not specifically identify the compound. The dust is dispersed (allowed to settle due to gravity) on a reagent-impregnated, gelatin-coated microscope slide. The reagent—sodium chromate, for example—reacts with lead to form a colored halo around each particle containing lead. One then simply counts the halos microscopically to determine the number of lead particles.

Another procedure has been used to identify the lead compounds in auto exhaust. The particles spread over the surface of a highly polished beryllium plate were examined by an electron microprobe analyzer as shown in Figure 4. This instrument, computer-controlled, systematically scans the particles with a finely focused pencil of electrons. Each time the beam strikes a tiny particle X-rays are created and emitted. If these X-rays show the proper wavelength for lead the computer stops the scanning sequence until that lead-containing speck can be analyzed completely and quantitatively. This requires less than one minute for each particle. The scanning then proceeds to the next lead particle. In one two-week period of continuous operation the probe found and analyzed over 12,000 individual lead particles.

The problem presented by water-borne samples is one of decreased particle sizes; most large particles will have settled out. Particles smaller than about a few tenths of a micrometer (10 millionths of an inch, for example) cannot usually be identified by the methods described. The microscopist can, however, identify these small particles by electron microscopy and its auxiliary techniques. The most sophisticated of these tools is the A.E.I. Scientific Apparatus Ltd. EMMA (Electron Microscope MicroAnalyser) (See Figure 5) It is a combined electron microscope and microprobe anaylzer. The identification of asbestos in water supplies is a good example of the application of an EMMA. A sample of water is filtered through the finest membrane filter. A few square millimeters of the filter are cut out and placed on a carbon-coated electron microscope grid. The filter itself is dissolved in a solvent vapor system, and the particles are left supported on the thin carbon film. The grid is then placed in the EMMA and scanned visually at about 20,000 times for fibers. Each suspected asbestos fiber is then analyzed chemically *in situ* by the microprobe and by selected area electron diffraction (identification of elements from the wave lengths of their electrons). This determines its crystal structure to confirm asbestos and identify precisely the mineral type.

Microscopy is a sophisticated technique for analyzing particles hazardous to health. A well-trained microscopist with the necessary equipment can quickly and positively identify and characterize suspect particles.—**End.**