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Modern Microscopy on the Light Side - - - Fibers, Fibers Fibers Everywhere

Richard E. Bisbing, Senior Research Microscopist
McCrone Associates, Inc.

In antiquity men and women consumed more labor to produce products from fiber bearing plants and animals than any other activity. Today the manmade fiber industry has reached dazzling heights trying to improve on the quality of natural fibers like wool, cotton, and asbestos and at the same time trying to offer the product at a better price. The identification of the tiny textile fiber fragments which cover our clothes and floors and contaminate our manufactured products illustrates how light microscopy can help improve the work environment, keep our products clean, and solve the most serious crimes. The consulting microscopist sees fibers as penultimately a problem of materials identification and finally as part of an intriguing mystery. In other words, from an archaeologist's point of view, fabric analysis always reveals something of the weaver in the same way as a forensic scientist learns something of the criminal through identification of extraneous fibers on the victim's clothing.

Mysteries with clues in the dust and light microscopy have a glorious history together. By 1930 Locard had described how the microscopic debris that cover our clothes and bodies are the mute witnesses of all our movements and all our encounters. In 1954, the Armour Research Foundation used an atlas of photomicrographs depicting the types of dust particles among the air-borne nuisances to which the residents of the City of Chicago were subjected. They found that wind-generated dust included fibrous materials derived from old newspapers, magazines, cardboard boxes, handbills, candy and gum wrappers, and clothing. Research on asbestos fibers in the workplace led to a better understanding of the health effects of airborne dust and, at the same time, demonstrated the important role of the microscopist in the control of asbestos as a contaminant in the air we breathe. Likewise, today, cleanliness has become mandatory in the production of integrated circuits and pharmaceuticals.

It is no secret that an experienced microscopist using polarized light microscopy can readily identify all generic classes of fibers. The best tool for fiber identification is the microscope because morphological features of most fibers, particularly the natural fibers, are diagnostic. Although the chemist knows that infrared spectroscopy is useful for identifying the chemical composition of acrylic fibers, how would one differentiate between cotton and linen or wool and silk with only an infrared spectrometer? Simple optical tests with the microscope, like comparing the refractive indices of individual fibers with the refractive index of the mountant, makes identification of man-made fibers rapid and certain. Attachments like dispersion staining objectives, fluorescence illuminators, and microspectrophotometers may provide a means to additional information, such as how they were dyed, but the initial fiber identification is easily accomplished by polarized light microscopy alone.

How can the light microscope assist in answering some new questions for research? Consider the following! What effect do airborne glass and ceramic fibers have on indoor air quality in new buildings with sick building syndrome? Can lung cancer be partly attributed to inhaled cigarette filter fibers? How are experiments in the weightless environment of space labs affected by the abundance of clothing fibers circulating in the space module? Where did the orange acrylic fibers found on a victim of a serial killer originate? On the lighter side, what did the Native American use to weave a 1500 year old fabric preserved in a cache of prehistoric copper artifacts in Michigan's Upper Peninsula? Or, what fibers were used to make the paint brushes found on a schooner lying at the bottom of Lake Michigan for 100 years? Each of these mystery investigations will begin on the light side of modern microscopy in order to rapidly identify the origin of the questioned fibers.

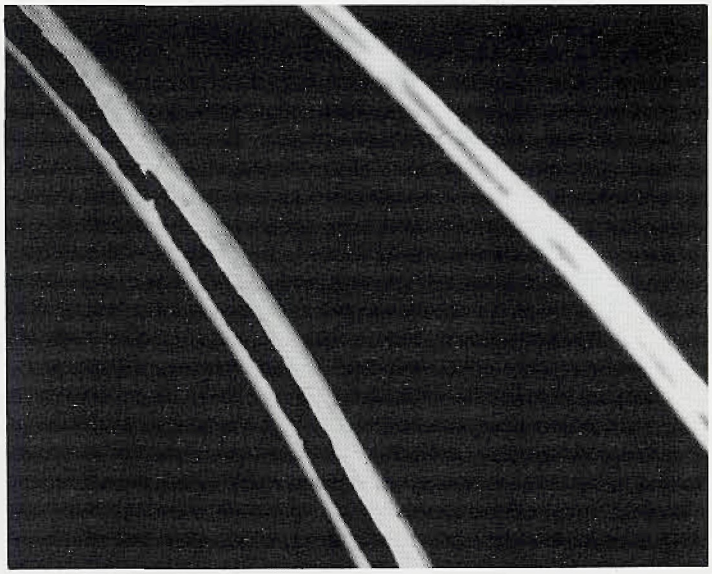

Figure 1: Two alpaca fibers recovered from the sweater of a murdered baby-sitter. These bright yellow fibers were found in abundance and the microscopist insisted that the suspect must have been wearing a garment not seized at the time of his arrest. When investigators returned to the suspect's residence, sure enough, a bright yellow golf sweater had been thrown in the corner. The yellow alpaca fibers on the victims's sweater matched in every detail the fibers comprising the golf sweater. To make the connection complete, white acrylic fibers like those making up the victim's sweater were found on the golf sweater. When body fluids matched and hairs on the victim were associated with the defendant, he was convicted of murder.

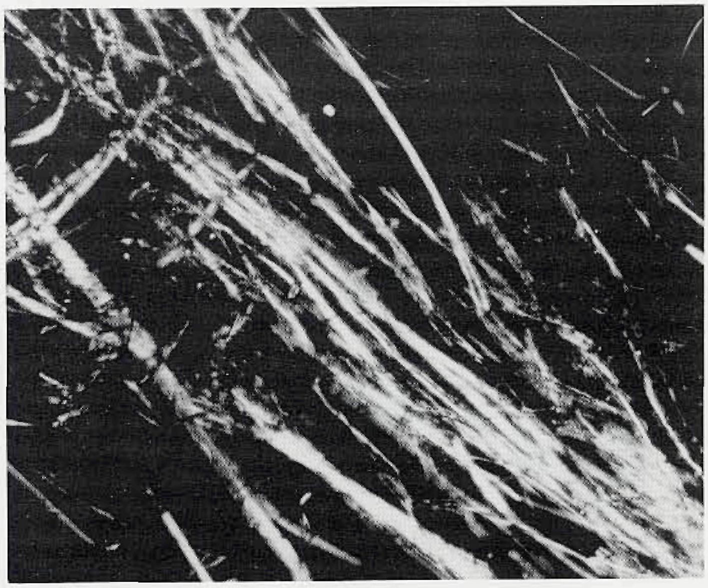

Figure 2: The source of these fibers will surprise you. In a forthcoming issue, Lou Solebello of McCrone Associates will describe how light microscopy is used to help the manufacturer and consumer of industrial minerals.