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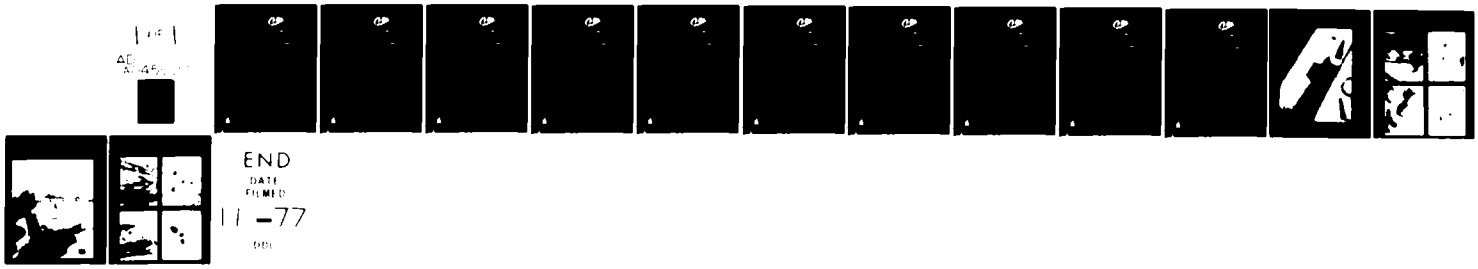
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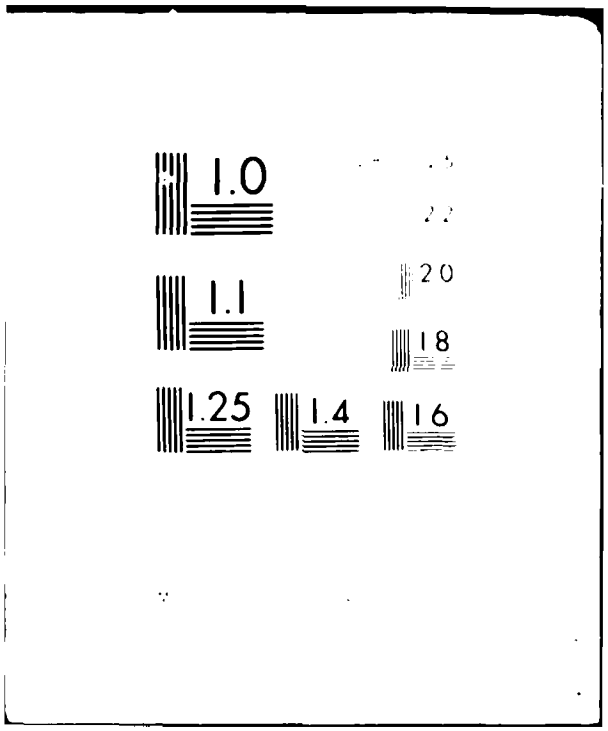
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Particles of debris emanating from an asbestos containing dental laboratory material were characterized with the scanning electron microscope and x-ray microprobe. The dimensions and composition of these particles suggest their potential to behave as subtle carcinogens. With almost daily use of dust producing asbestos in the dental laboratory, the improper handling of this substance could be hazardous to the health of dental personnel. It is recommended that high standards of personal and laboratory hygiene be employed in the handling of asbestos.

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ASBESTOS: A SUBTLE CARCINOGEN IN THE DENTAL LABORATORY

SEM AND MICROPROBE STUDY

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Commercial materials and equipment are identified in this report to specify the investigative procedure. Such identification does not imply recommendation or endorsement or that the materials and equipment are necessarily the best available for the purpose.

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** Chief, Division of Dental Materials
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Risks encountered in dental practice have become foci of a number of studies. Dangers associated with the inhalation of particulate matter (bacteria, viruses, enamel, dentin, calculus and amalgam) from microbial aerosols[1,2] produced during the use of high-speed rotary instruments have been addressed. Also, investigations have been conducted to establish and to define acceptable limits for operating room levels of mercury vapor[3-5] and of nitrous oxide.[6-8]

Recently, concern has been shown for asbestos fibers which emanate from the powder component of some periodontal dressings as well as from liners for casting rings and crucibles.[9-10] The present study was conducted to sample and to characterize particulate debris encountered in the use of asbestos in the dental laboratory.

MATERIAL AND METHODS

A. A three-inch segment of one-inch wide ring liner was torn from a roll of asbestos* by each of two laboratory workers. Particulate matter remaining on the thumbs and index fingers of the test subjects was removed with the use of acetate tape. Additionally, the sites from which debris had been removed were resampled after the workers washed and dried their hands.

Two three-inch strips of the asbestos were heated in a burnout furnace at 1,300°F. for 45 minutes. The strips were cooled to room temperature in open air and torn by two volunteers. Sampling of particulate matter from the thumbs and index fingers of these individuals was accomplished as described above.

B. Samples of debris were collected on acetate tape from a bench top upon which 20 phosphate-bound investment molds had been broken from asbestos-lined metal casting rings. Additional particles were removed from a wall

* Material supplied with Ceramigold Investment, Whip-Mix Corp., Louisville, KY 40217.

against which the bench was located, from the muffle of a furnace, from a casting machine and from a drawer in which a roll of ring-liner had been stored.

The sampling tapes were sealed to aluminum stubs. The debris-containing side of each tape was coated with gold and palladium or carbon and examined with the use of a scanning electron microscope.+ Photomicrographs of the collected matter were analyzed for determination of shape, size and distribution of particulate components. Elemental constituents of selected carbon coated particles were determined by energy-dispersive x-ray microanalysis.#

RESULTS

A. Material collected from thumbs and index fingers: Scanning electron microscopic examination showed aggregates of relatively straight, parallel fibers and single randomly dispersed fibers (Figure 1). The fibers, though fragmented, did not exhibit axial cleavage. Diameters of the linear particles ranged from 0.10 to 1.0 μm. Generally, fiber length exceeded 200 μm. Morphological differences between the particles broken from unheated and heated strips of the test material were not detected.

Dispersive x-ray analysis of selected particles revealed that magnesium and silicon were the predominant constituents of the test material. However, small amounts of iron were also detected as well as sulfur and calcium (Figure 2). Approximate elemental composition of the fiber was as follows; magnesium 45%, silicon 40%, sulfur 2%, calcium 2% and iron 4%. Heating at a conventional mold burnout temperature did not alter the elemental composition of the woven fibers.

+ Scanning Electron Microscope, model 1000, Advanced Metals Research Corporation, Burlington, MA 01803.

Energy Dispersive X-Ray Analyzer, model 707A, with EDIT II Software, EDAX International, Prairie View, IL 60069.

Fibers were not detected in the particulate matter removed from the digits of washed hands. Occasional small spheroidal, and plate-like particles found in one sample exhibited a broad range (titanium, silicon, chlorine, potassium, calcium and iron) of elemental constituents.

B. Material collected from laboratory bench, storage drawer, wall, furnace and casting machine: Samples of debris removed from the laboratory bench and wall contained fragmented slender particles (Figure 3). Particles of similar configuration were recovered from the casting machine and from the storage drawer. Analysis revealed that these filamentous particles were composed of magnesium, silicon, sulfur, calcium and iron in the same relative concentration as found on the finger tips. Particles detected within the muffle of the furnace were not fibrous (ration of length to diameter less than 3 to 1). Constituents of these particles included silicon, phosphorous, calcium and sulfur.

DISCUSSION

Asbestos is a term used to identify any one of several minerals which can be crushed into fibers. However, a particular mineral substance known as chrysolite is the principle source of commercial asbestos.[11] Chrysolite is a hydrated silicate of magnesium, the approximate composition of which is 37 to 44 percent silicon dioxide, 39 to 44 percent magnesium oxide, 12 to 15 percent water and 1 to 6 percent iron oxide. Analytical data suggest that the fibrous material examined in this study is chrysolite. Compositional features of the nonfibrous particles removed from the fingers of washed hands and from the furnace muffle infer the presence of debris from refractory investment materials.

The occupational risk associated with asbestos exposure has been well documented.[12-16] In man, exposure to asbestos dust is associated with an in-

creased incidence of tumors of the lung[17] and with pleural and peritoneal mesothelioma.[18] Asbestos fibers are subtle carcinogens that do not produce an obvious exposure-response relationship. Usually a long latency precedes the onset of fibrogenic or carcinogenic activity and the effects of repeated exposures over long periods of time are cumulative.[19]

The threshold limit value (TLV) below which asbestos would not affect adversely the health of man is not known. The current eight-hour time weighted TLV for asbestos is 2 fibers per cubic centimeter of air,[20] however, this limit has not been evaluated with regard to its effectiveness in the prevention of asbestos-induced disease. Additionally, the mechanisms by which fibrous materials produce malignant disease are uncertain. It has been shown, however, that the degree of carcinogenicity is related to fiber size rather than to composition.[21] Data from animal experiments have indicated that durable fibers less than 3 μm in diameter and more than 20 μm in length present the greatest hazard, and the fibers described in this report fall within this range of size.

Since it has been shown that cigarette smoking increases the risk of lung cancer in asbestos workers, it should be discouraged especially within the working area.[22]

The actual risk incurred in the use of dust producing asbestos in dental laboratories is unknown. However, the potential for inhalation or ingestion of asbestos particles by dental laboratory workers would appear to be greater than that of members of the general population (Figure 4). The need for rigorous standards of personal and laboratory hygiene in the handling of asbestos is obvious. Hand washing for example as shown in this study effectively removes the material from fingertips. In view of these results reported here and in conformity with correct occupational health practices, the following protective measures are suggested in dental clinics:

1. Inform all office and laboratory personnel of the potential danger of asbestos.

2. Confine the storage and use of asbestos to a small area of the laboratory or to a small isolated working chamber.

3. Isolate operatories and other offices from the dental laboratory.

4. Insure the wearing of face masks and surgical gloves when asbestos or asbestos-containing debris is handled.

5. Encourage cutting in lieu of tearing of asbestos.

6. Prevent smoking and eating in the dental laboratory.

7. Prevent the transmission of asbestos waste by sewage lines and air exhaust systems to preclude its discharge within the community environment.

SUMMARY

Particles of debris emanating from an asbestos containing dental laboratory material were characterized with the scanning electron microscope and x-ray microprobe. The dimensions and composition of these particles suggest their potential to behave as subtle carcinogens. With almost daily use of dust producing asbestos in the dental laboratory, the improper handling of this substance could be hazardous to the health of dental personnel. It is recommended that high standards of personal and laboratory hygiene be employed in the handling of asbestos.

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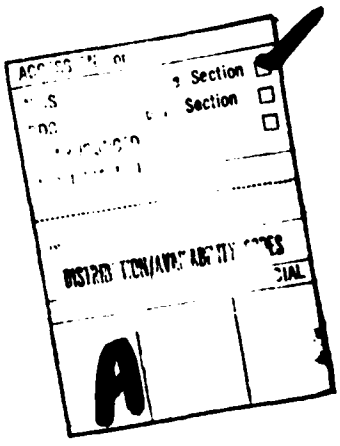
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Figure 1. Typical scanning electron photomicrographs of particulate matter removed from thumbs and index fingers of laboratory workers. (A) Aggregates from dry, unheated ring liner. Initial magnification was X50. (B) Aggregates from heated ring liner. Initial magnification was X50. (C) Particles of dry, unheated ring liner. Initial magnification was X5,000. (D) Particles of heated ring liner. Initial magnification was X5,000.

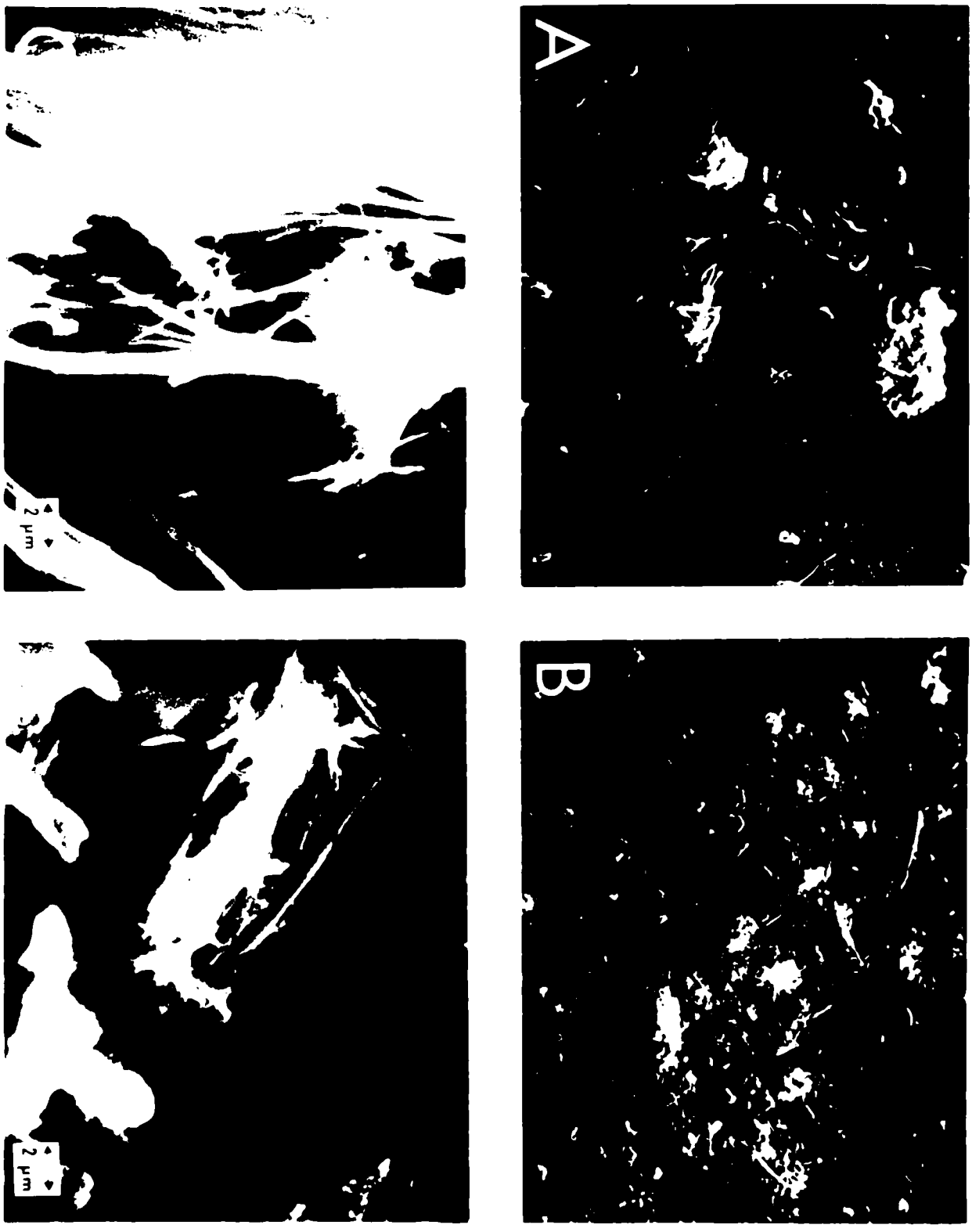
Figure 2. Dispersive x-ray analysis of a single fiber component of an asbestos casting ring liner.

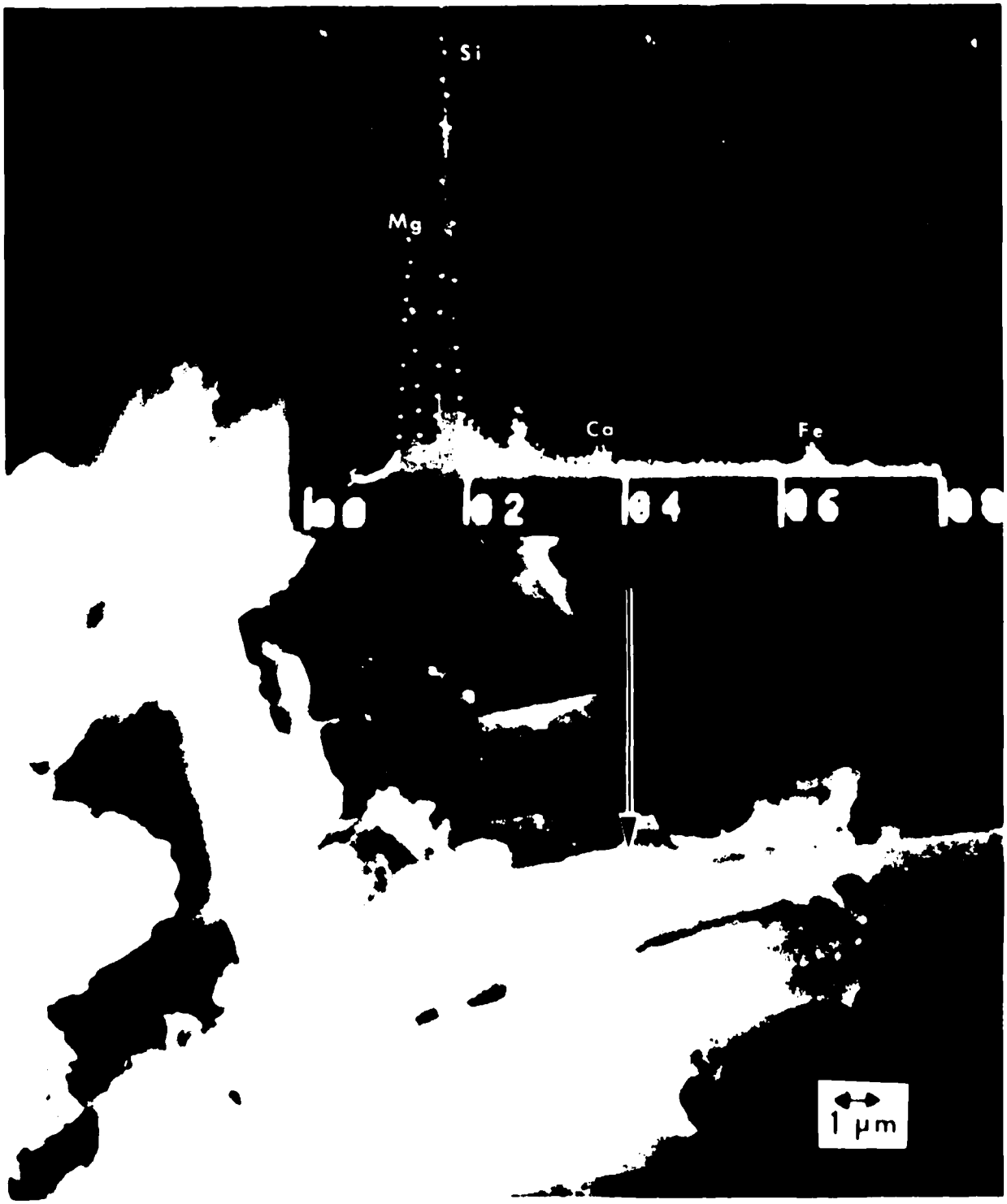
Figure 3. Typical scanning electron photomicrographs of debris from laboratory bench top and laboratory wall. (A) Full-field of bench top debris. Initial magnification was X50. (B) Full-field of wall debris. Initial magnification was X50. (C) Linear component of bench top debris. Initial magnification was X5,000. (D) Bundle of linear components of wall debris. Initial magnification was X5,000.

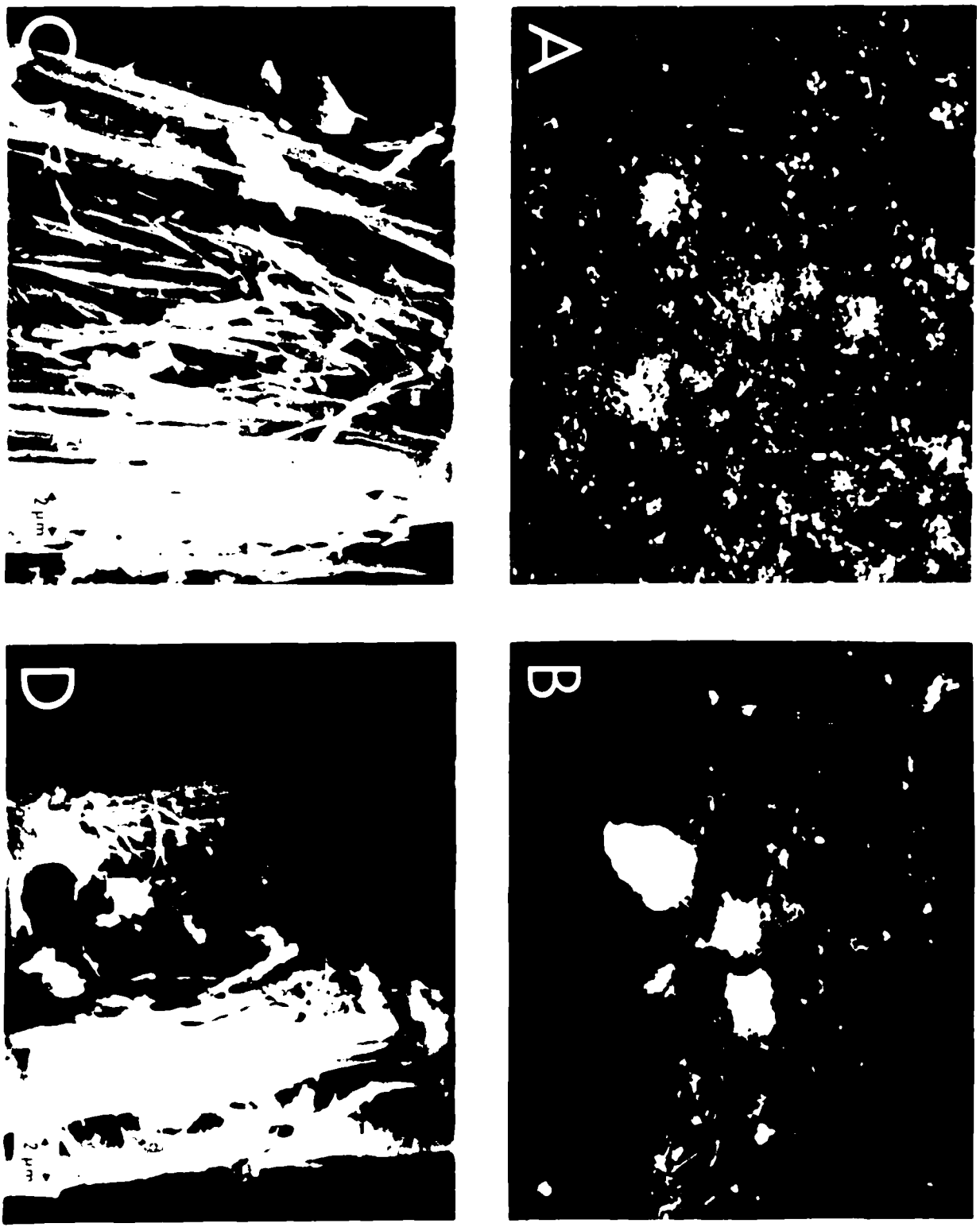
Figure 4. Fragmented debris from laboratory asbestos in storage drawer.






A
B
2 μm
2 μm


Si
Mg
Co
Fe
1 μm


A
B
C
D