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A METHOD FOR FINISHING COMPOSITE RESTORATIVE MATERIALS

by

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A METHOD FOR FINISHING COMPOSITE RESTORATIVE MATERIALS

SYNOPSIS

An instrument, designed for finishing composite restorative materials, was made by bonding 1-5 μm (microns) diamond particles to flexible paper discs. The surface finish left by this instrument was superior to that obtained by fine cuttlefish discs and inferior to surfaces that hardened in contact with polished glass.

In the past few years several new composite materials have been developed primarily as replacements and substitutes for silicate cements in Class III and V restorations in anterior teeth. They have also been used instead of direct filling resins in Class IV restorations, and in Class I and II restorations on an experimental basis.

These materials are composed basically of reinforcing fillers that are chemically bonded to a resin matrix. The fillers may be fused silica, quartz, various kinds of glass or other materials. In commercial products,* the resin matrix is composed of the hardened product of new monomers that were specially developed for composite materials.[1]

One of the shortcomings of the composite materials is that they cannot be finished to a smooth surface using instruments commonly available.[2,3] These instruments include various grades of sand, emery, garnet, cuttlefish, and other discs, mounted points containing silicon carbide, alumina or diamond particles, and various shapes and sizes of steel burs. The materials contained in these instruments are either too coarse, too soft, or both, to produce a smooth and glossy surface that is composed of hard particles of reinforcing filler embedded in a relatively soft resin matrix.

The lack of a smooth surface results in restorations that do not have optimum esthetic properties and do not

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* Typical products are: Adaptic, Addent, Blendant, Dakor, DFR, and Posite

feel smooth to the tongue. In addition, there may be other disadvantages associated with rough surfaces, such as a tendency to collect debris and harbor microorganisms.

The only method presently available to the dentist for achieving a relatively smooth surface on the composite restoration is to leave, undisturbed, the surface that was formed against the matrix strip. However, there is usually a need for recontouring and dressing down at least part of the restoration, thereby removing the matrix-strip finish.

This paper describes a method for improving the surfaces of the composite restorations using very small diamond particles bonded to paper discs. Results are presented in the form of scanning electron photomicrographs.

Materials and methods*

The composite materials on which the finishing procedures were evaluated were a commercially available product† (selected because of the relative hardness of its quartz reinforcing filler) and an experimental material containing fused silica beads as the reinforcing filler. Specimens were made in the form of discs that were allowed to harden between glass plates under light pressure from "C" clamps.

The following instruments were used in the finishing procedures: medium sandpaper discs,‡ fine sandpaper discs,‡ fine cuttlefish discs,‡ and diamond paper discs.

The diamond paper discs were prepared by applying a thin coating of epoxy glue,§ thinned with acetone to a suitable

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* Certain commercial materials and equipment are identified in this paper to specify adequately the experimental procedure. In no instance does such identification imply recommendation or endorsement by the National Bureau of Standards or that the material or equipment identified is necessarily the best available for the purpose.

† Adaptic, Johnson & Johnson Co., New Brunswick, New Jersey

‡ E. C. Moore and Son Company, Detroit, Michigan

§ Fix'n Patch, Specialty Plastics Co. Inc., Baltimore, Maryland consistency, to a relatively stiff paper backing (the back side of a medium garnet disc). Diamond particles 1 to 5 μm (microns) in size* were applied to the wet surface by dipping a small brush into the thinned glue and then into the diamond particles and applying the mixture to the disc surface until it was completely covered with the particles. The discs were allowed to remain undisturned for 24 hours before use.

Three different surfaces for each composite material were evaluated: (1) as cast against glass plates; (2) as prepared by finishing with medium sandpaper discs to remove the resin-rich outer surface and to simulate removal of excess material clinically, then with fine sandpaper discs, and finally with fine cuttlefish discs; (3) as prepared exactly as in (2) except that the surface was further finished with the diamond discs. All discs were used dry in a low-speed dental handpiece.

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* The diamond particles were obtained at the National Bureau of Standards, Washington, D. C. Commercial sources include: The Amplex Corporation, Bloomfield, Connecticut, Diamonds Unlimited Corporation, Rochester, New York, and J. K. Smit and Sons, Incorporated, Murray Hill, New Jersey

Each of the three surfaces for each material was examined tactually with an explorer, visually and from pictures obtained by means of a scanning electron microscope.

Results

The photographs of the commercially available material, Adaptic, are shown in Figure 1. The surface as cast against the glass plates (Fig. I-A and B) appears to be the smoothest. The texture of the surface is assumed to be due to shrinkage of the resin between the filler particles during hardening.

Figure I-C and D show the surface left by the cuttlefish discs. This surface indicates that a great many of the filler particles have been pulled from the surface and those that remain show little evidence of being significantly planed by the finishing procedure.

Figure I-E and F show the surface obtained by the diamond disc. These photographs show that the filler particles were planed smooth and were not pulled from the surface. The resin matrix has also been finished relatively smooth and is more nearly at the same height as the filler particles compared to the surface shown in Figure I-C and D.

Very small scratches can be seen on the exposed surfaces of the filler particles in Figure I-F. Such scratches would be expected to decrease the visual shininess of the composite material by scattering light. The scratches would have to be smaller than the wavelength of visible light (about 0.5 μm) to yield a surface having maximum shine.

Results similar to those shown in Figure 1 were obtained in finishing the experimental composite material.

The visual and tactile examinations revealed that those surfaces prepared by the diamond discs were smoother than those prepared with cuttlefish discs as observed in reflected light and by feel as the point of an explorer was lightly traced over the surfaces. The smoothest surfaces were those cast against the glass plates.

Although dental porcelains do not come under the classification of composite materials, it was discovered that the diamond paper discs would produce highly polished and very smooth surfaces on porcelain that had previously been ground. This procedure would be valuable in achieving a highly polished surface on areas of porcelain that require removal of the final glaze during adjustments.

Discussion

This preliminary study was carried out in part to determine the validity of certain hypotheses concerning the requirements of finishing instruments for the composite materials. These hypotheses were:

1. If a light-reflecting surface is to be obtained, the cutting particles must be small enough so

that the scratches left by the instrument are narrower than the wavelength of visible light. When this occurs, light is reflected instead of scattered by the "hills and valleys" left by the finishing instrument.

A visual examination of the specimens indicated that diamond particles in the size range of 1 to 5 μm (microns) were partially successful in bringing about a light-reflecting surface. This was not the case when the cuttlefish discs were used, as they produced a dull non-reflecting surface.

2. The cutting particles must be relatively hard as compared to the filler material. When materials that are relatively soft are used, they are not effective in planing the filler particles. The ineffectiveness of the cuttlefish discs was interpreted to be due to their relative softness.

Whether particles as hard as diamond are necessary is not known. Some preliminary testing with emery (aluminum oxide particles, about 15 μm in size) paper discs revealed that the composite surfaces obtained were smoother than those obtained by the cuttlefish but not as smooth as those left by the diamond discs. Other hard materials[4,5] such as boron carbide, silicon carbide and even aluminum oxide particles should be investigated because they are less expensive than diamond. However, the hardness of diamond is very much greater than these other materials, and thus might be more effective.

3. The cutting particles should be rigidly bound to the finishing instrument to obtain the most-nearly plane surface. When loose particles were used, (one-micron diamond paste on a soft wool-felt wheel) they polished only the tops of the filler particles and left deep asperities between particles that projected out of the surfaces. The surfaces produced

however, were visually shinier than those left by the cuttlefish discs.

4. It follows from 3 (preceding) that all debris and loose particles should be immediately and continuously removed from the operating field. Coarse particles from initial finishing procedures would partly nullify the effects of the ultrafine particles of the polishing instruments if allowed to remain in the operating field.

5. The surface of the instrument should be as flat and smooth as the size of the cutting particles will permit. If such is not the case, there will be a tendency for grooves or scratches to be formed that are analagous to those caused by larger particles.

6. The cutting instrument should be somewhat flexible, or at least be flexibly mounted on the mandrel. A flexible instrument distributes lighter forces over a larger area, which minimizes heat formation and the removal of filler particles from the resin matrix.

The foregoing are not presented as established facts, but rather as working hypotheses that may guide further research and development that is needed in this field.

The diamond disc instrument described in this report is useful for only a short period of time due to the temporary nature of the paper backing. Because of the relative expense of using diamond particles, a more permanent backing such as flexible plastic or metal is needed. Strips that can be passed between the teeth are also needed, since a disc is not appropriate for finishing proximal surfaces. Instruments of other appropriate shapes and sizes are likewise needed for polishing lingual and other concave surfaces.

While relatively coarse cutting features are needed on instruments for gross reduction of excess composite material, the final polish requires abrading particles of extremely hard material in sizes of about one µm (about 4×10^{-5} inch) or smaller. Freedom from coarser particles is imperative, since even a few of these badly scratch and roughen a polished surface.

Summary and conclusions

An instrument for finishing composite restorative materials was constructed of 1 to 5 μm (microns) diamond particles bonded to flexible paper discs by means of an epoxy adhesive. The surface finishes obtained with the diamond discs were superior to those obtained by fine cuttlefish discs, but not as good as the surfaces left by letting the material harden in contact with glass plates. Evaluations of surfaces were made by means of photographs taken with a scanning electron microscope, by visual examination of reflected light and by subjective tactile sense using a dental explorer.

Similar instruments need to be developed that utilize sub-micron diamond or other very hard abrasive particles. These polishing particles should be durably mounted. Not only flexible discs, but other instruments of shapes and sizes that can be used on proximal and lingual tooth surfaces should be made available to dentists who restore teeth with composite materials.

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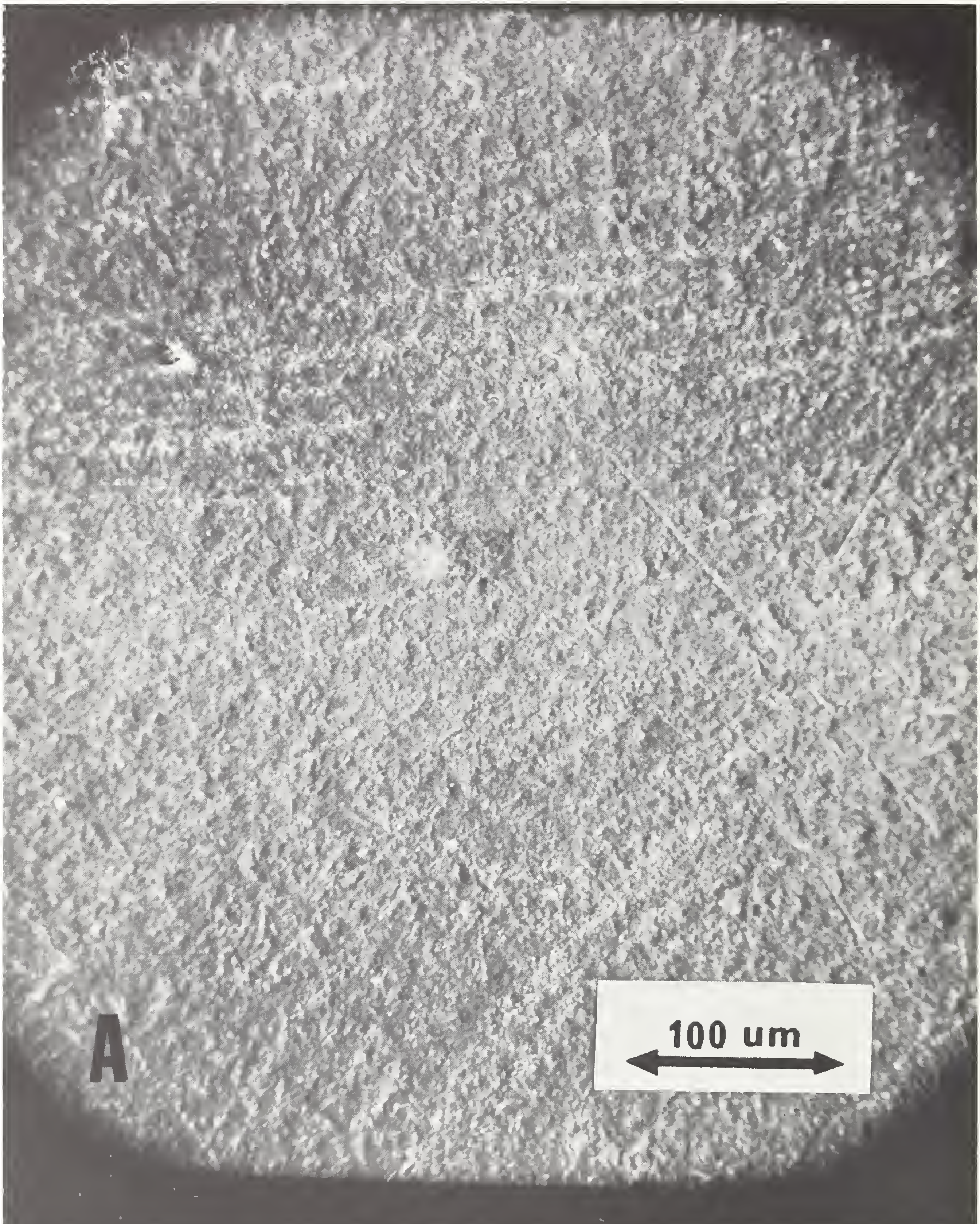
Legend

Figure 1: Photographs of Adaptic taken with a scanning electron microscope. A and B show the surface obtained by allowing the material to harden between polished glass plates. The lines seen on the surface are artifacts. C and D show the surface obtained by finishing with fine cuttle-fish discs. E and F show the surface obtained with the discs that were coated with 1 to 5 μm (micron) diamond particles.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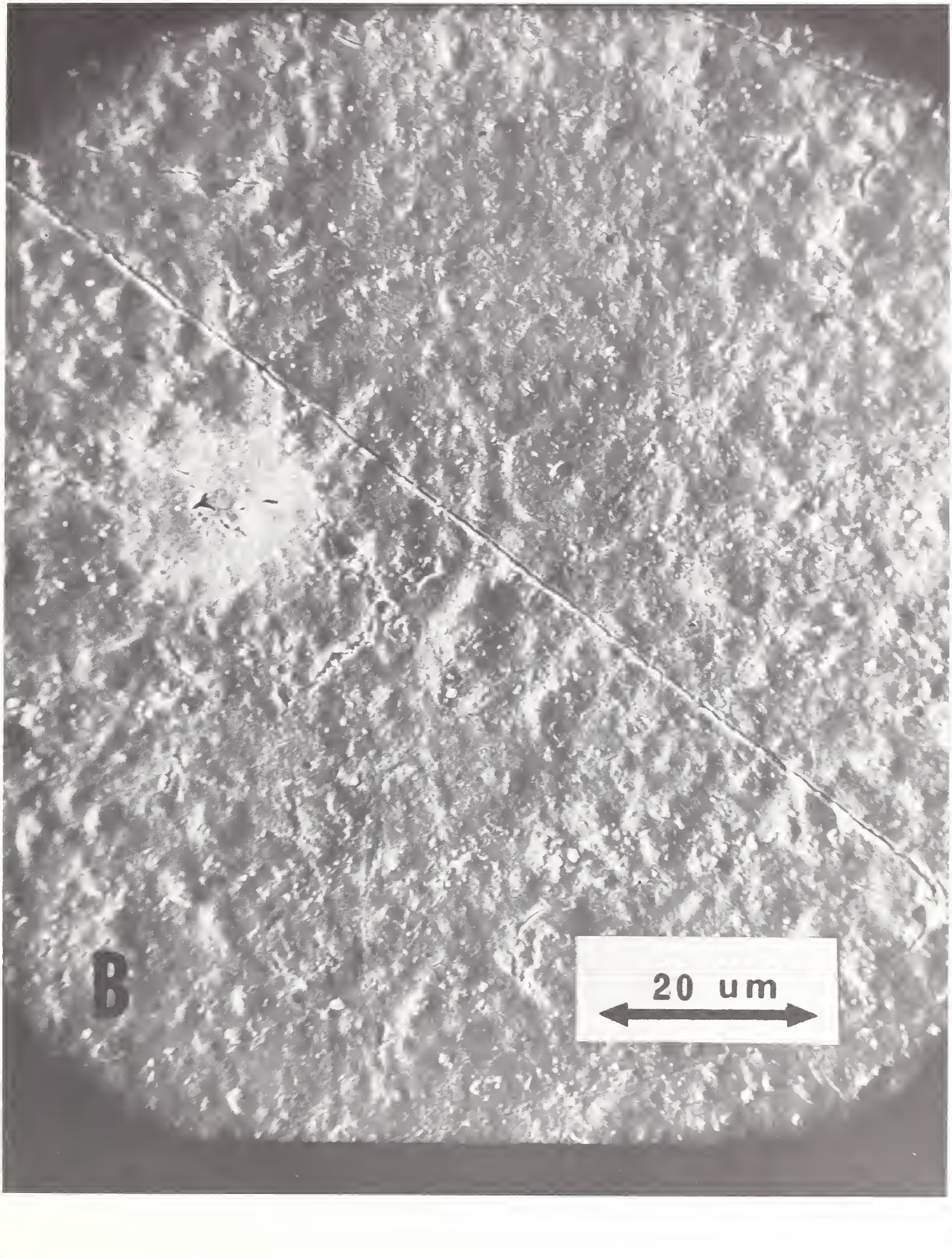
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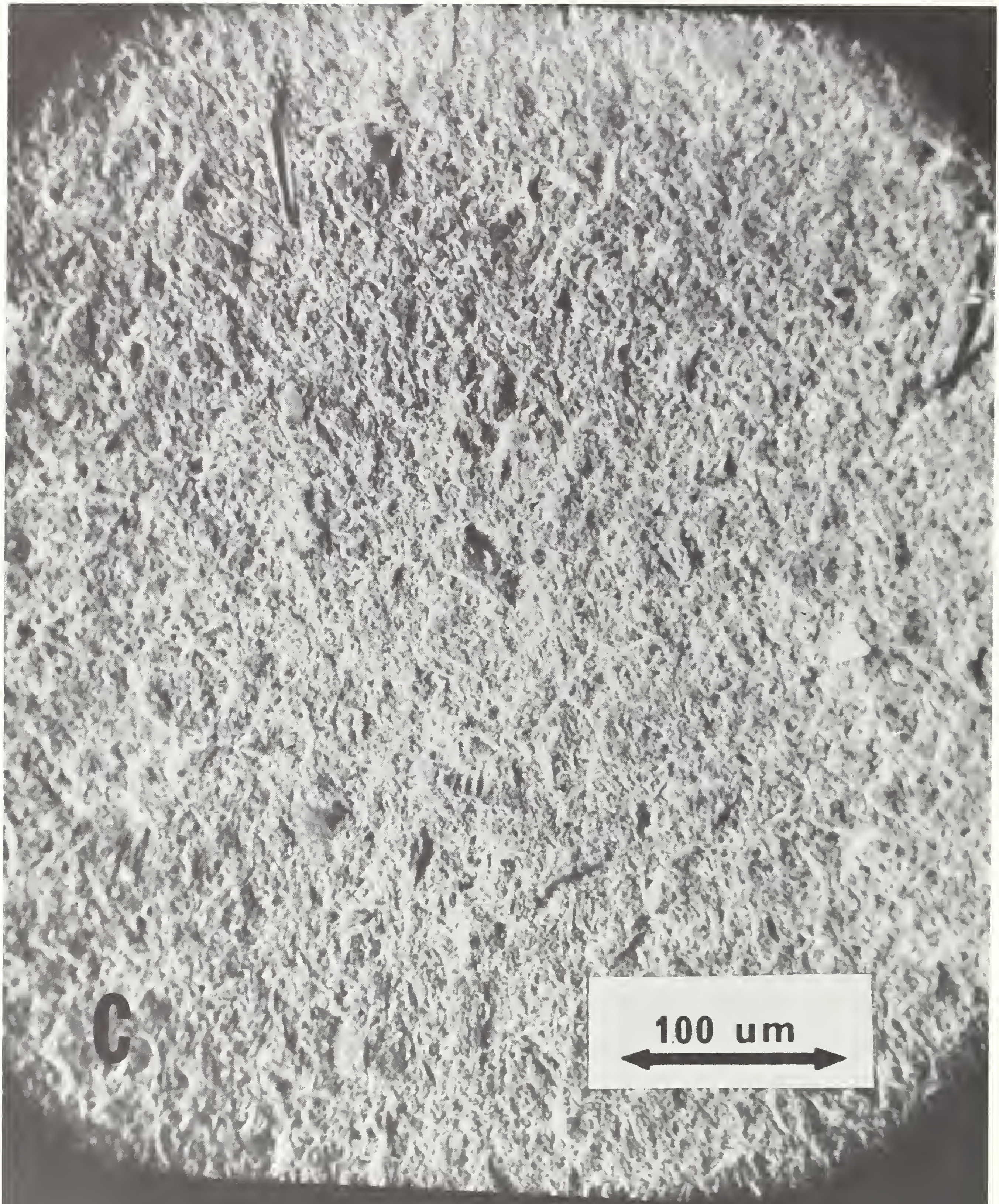
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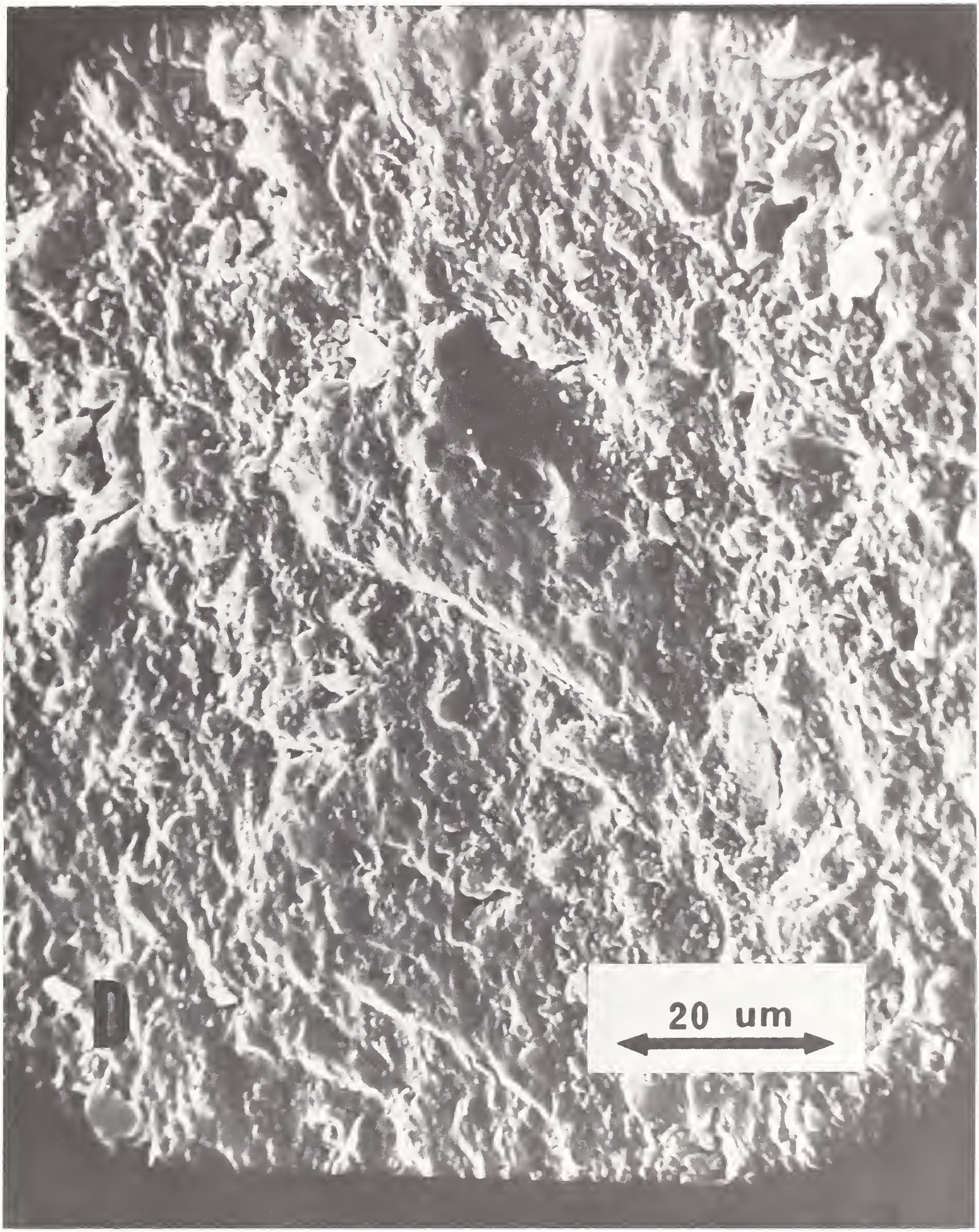
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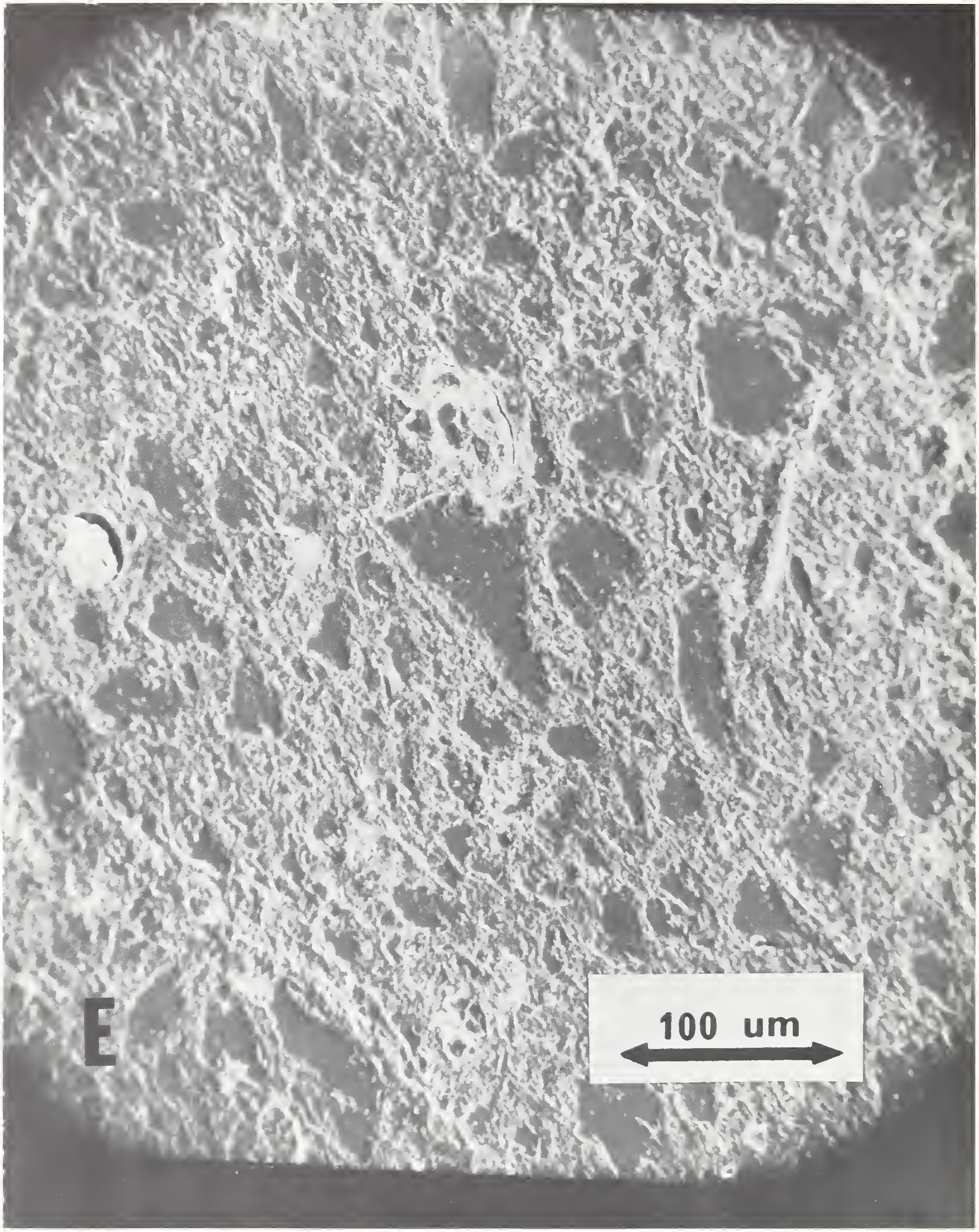
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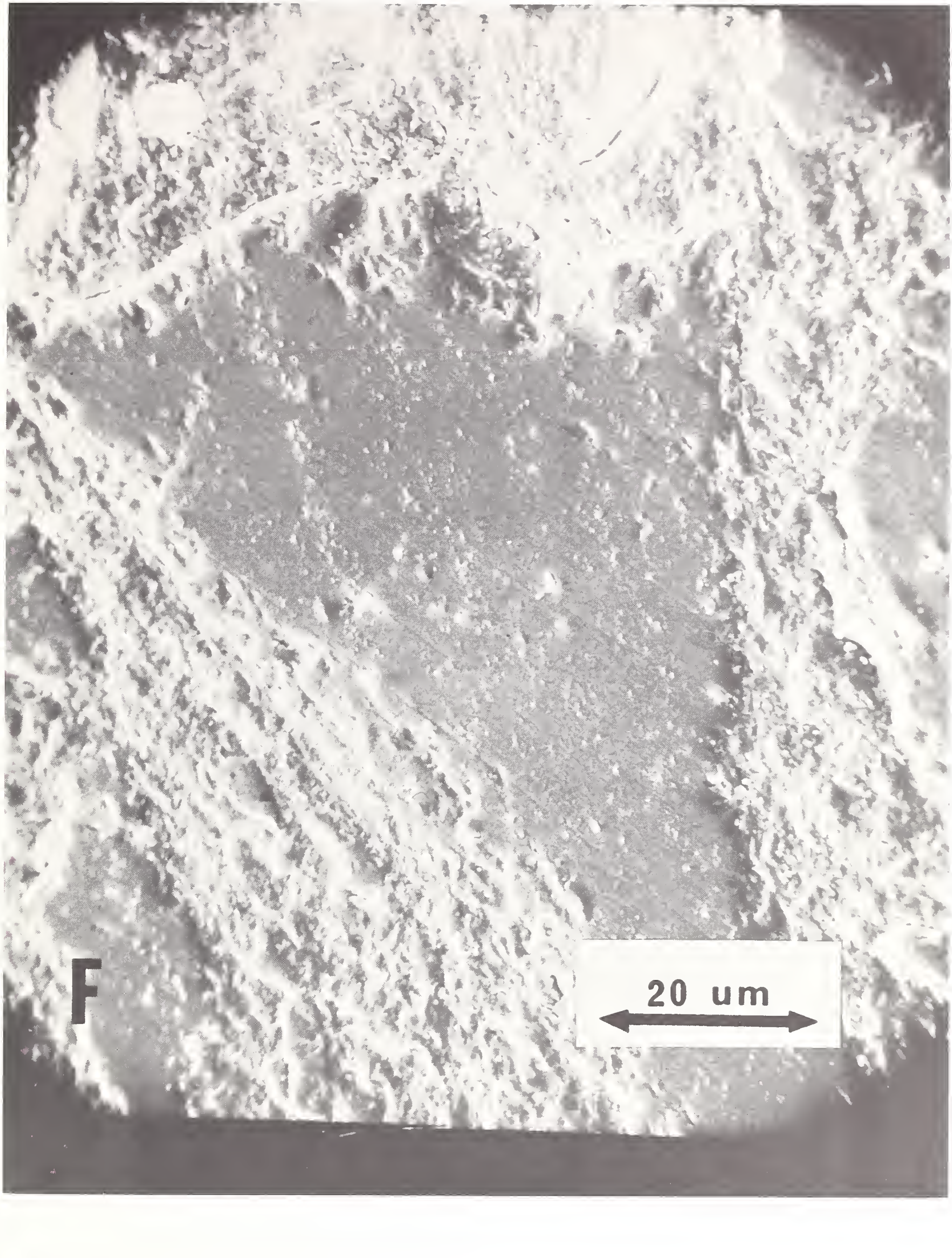
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