# TECHNICAL NOTE

## ELECTRON MICROSCOPY OF COLLAGEN FILM SURFACES

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**ABSTRACT**

Collagen films were prepared from comminuted calfskin corium by electrodeposition and by evaporation in room atmosphere at pH 3.5. When the surfaces of these films were examined by scanning electron microscopy and by transmission electron microscopy of carbon replicas, the electrodeposited films showed a periodic structure that was absent in the films formed by evaporation.

The recent expansion of interest in collagen films (1), with the prospect of using them as raw material in fabricating anatomical components for use in prosthetic surgery (2, 3), has given rise to consideration of the possibilities of other applications. Because of the characteristic electronic charge pattern of the collagen molecule, these films would be expected to have unusual permeation and ion exchange properties which might be used to advantage in reverse osmosis and other fractionation processes. Hide scraps are a suitable source of collagen for this purpose; thus collagen films might serve as a by-product that will add diversification to the leather industry and utilize some of the waste material. As a first step in developing such applications, collagen films were prepared by electrodeposition and by evaporation in room atmosphere and were examined by scanning electron microscopy and transmission electron microscopy.

Calfskin corium was adjusted to pH 5.5 via a mixture of 0.05 percent propionic and 0.10 percent benzoic acids and then ground in a disc mill set for a 0.010 inch gap. The slurry was then adjusted to pH 3.5 with hydrochloric acid and films were formed by electrodeposition and by evaporation.

The electrodeposited films were made by inserting electrodes in a slurry that held 1.5 g. of collagen fibers in 600 ml. of mixture and passing a current of 50 milliamperes at 100 volts for 15 minutes at room temperature. The cathode was a carbon rod one cm. in diameter dipping ten cm. into the slurry. The anode was two pieces of platinum foil one cm. square. A film formed only on the carbon

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cathode and reached a thickness of about 0.004 inches when subsequently dried. During this process the temperature rose to 30°C. The evaporated films were made by spreading the slurry on a glass plate and allowing the liquid phase to evaporate at room temperature.

The difference in surface structure of the two types of collagen film as indicated by scanning electron microscopy are shown in Fig. 1, where (*a*) is an electrodeposited film, and (*b*) is a film formed by evaporation. The corresponding

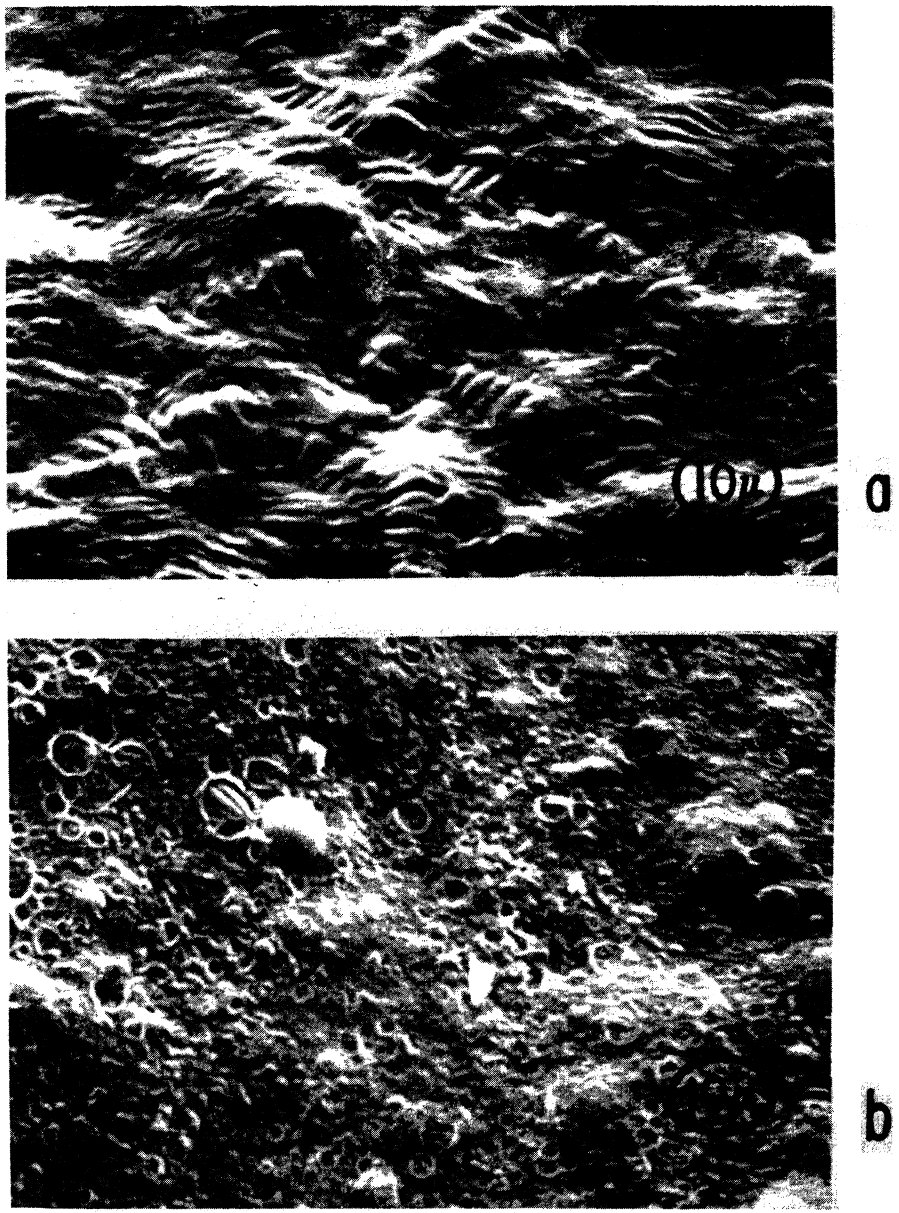


FIGURE 1.—Scanning electron micrographs of collagen films prepared by (*a*) electrodeposition and (*b*) evaporation.

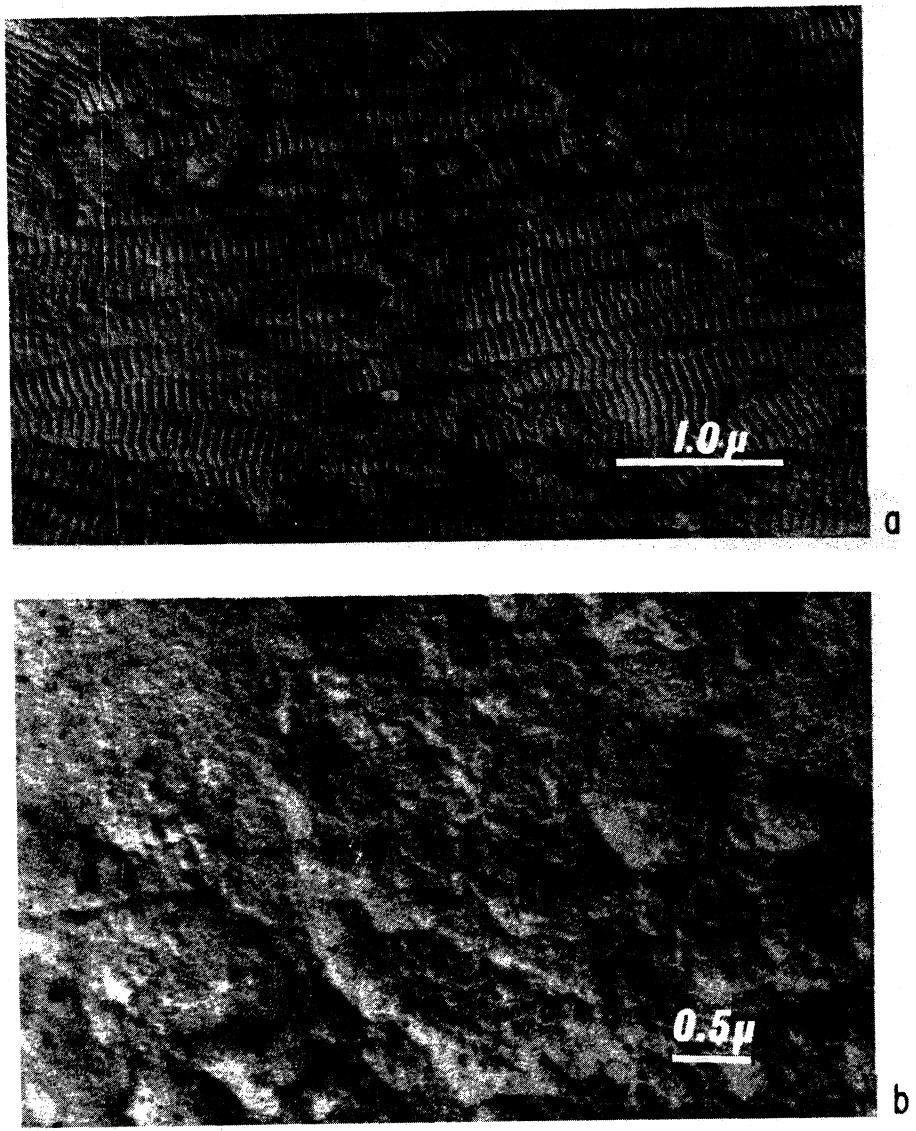


FIGURE 2.—Transmission electron micrographs of preshadowed carbon replicas of collagen films prepared by (*a*) electrodeposition and (*b*) evaporation.

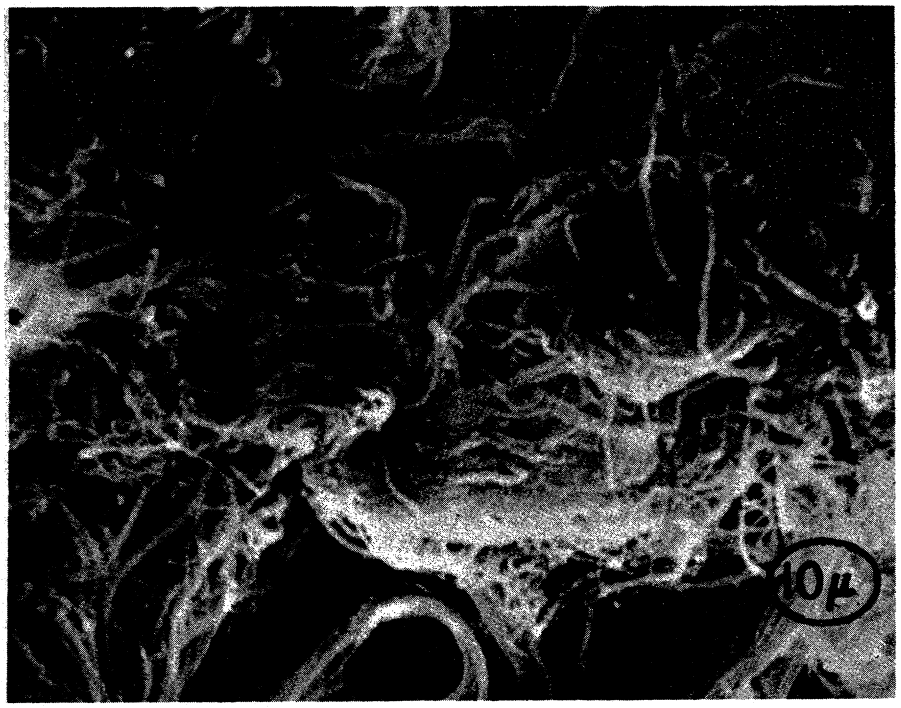

FIGURE 3.—Scanning electron micrograph of collagen reconstituted from solution by dialysis to exhaustion of electrolyte.

transmission electron micrographs of platinum preshadowed carbon replicas of film surfaces are as shown in Fig. 2. The scanning electron micrographs of the electrodeposited film show a repeating structure. The periodicity seems to bear no relation to the characteristic striations of collagen fibrils, but instead seems to delineate a parallel array of fibers. The transmission electron micrograph of the electrodeposited film shows a structure, on the other hand, typical of native collagen. For purposes of comparison a scanning electron micrograph of collagen reconstituted from solution by dialysis to exhaustion of electrolyte is shown in Fig. 3. These results are contrary to the findings of Karube *et al.* (1), who have reported that electrodeposited films made over a wide range of pH have an irregular structure and fibers formed by extrusion show a uniform pattern of parallel fibers in transmission electron microscopy.


## ACKNOWLEDGMENT

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