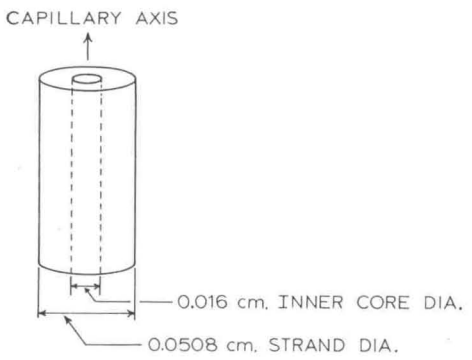

Fig. 3. Schematic diagram of strand indicating inner and outer sheaths discussed in the text.

in microcracks located mainly in the central core of the strands (see Fig. 2). The fusion curve for the sample shown in Figure 2 was both lower and broader in melting temperatures than curves for samples crystallized at 136°C.[13] The existence of microcracks running both perpendicular to the strand length and at 45°, together with the observed lower melting point, were consistent with the disruption of the crystalline structure due to excessive stress. The central core structure failed under tensile stress, as is indicated by the cracks in the region perpendicular to the strand length; the structure failed in shear near the outer radius, as is indicated by cracks oriented at 45° to the tensile force (the maximum-shear plane). This was consistent with a previous observation that the maximum longitudinal velocity gradient responsible for drawing occurs along the central axis of the strand, while the maximum radial velocity gradient, a shearing effect, occurs near the outer radius.[12] Morphological observations described in this paper indicate basic structural differences between the inner core and the outer sheath of the strand which are defined schematically in Figure 3. In all probability, these differences arise from the different orientation effects attributed to the different velocity gradients existing in the central core and the outer sheath regions during the crystallization process.

Scanning Electron Microscopy

In spite of the 200 Å resolution limit of the SEM, its large depth of field proved to be invaluable in defining the structure. Two distinct fibrous textures were observed. One of these, shown in Figure 4, was found only in the outer sheath of the strand. These 3000 Å diameter fibers, oriented parallel to the flow direction, formed the dominant structure for radius values 0.008–0.025 cm delineating the outer sheath (see Fig. 3). A cross texture running perpendicular to the 3000 Å diameter fiber axes was observed upon close inspection of Figure 4. This texture appeared to be spaced more or less periodically along the main fibers at 500 Å intervals and often spanned several adjacent fibers. The cross texture appeared to be

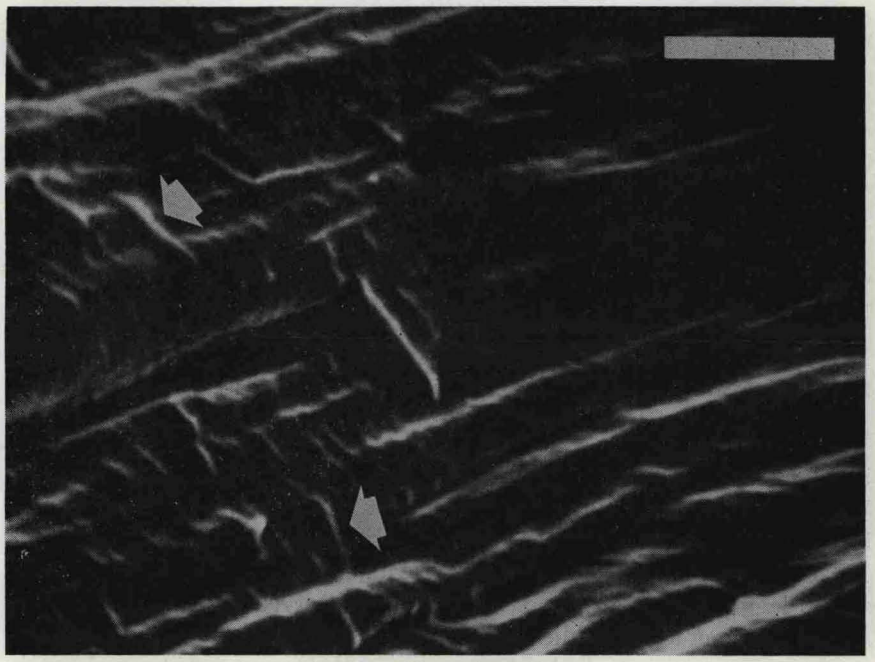

Fig. 4. Outer-sheath texture. Scanning electron micrograph; bar, 1 μ.

basically lamellar; however, the SEM resolution limit was approached in attempting to further define the texture. In many cases, this lamellar texture was observed to twist around the central fiber thread in a helical fashion. Both the size and orientation of the fibers were consistent with the previously published observations[12] concerning the scanning electron micrograph of a sample fractured by the bending at liquid nitrogen temperatures.

The inner core of the strand consisted of fine, flat, ribbonlike structures, rather than the 3000 Å diameter fibers comprising the outer sheath. When freshly cleaved samples were first introduced into the SEM, the ribbons appeared to be flat and aligned parallel to one another as well as to the capillary axis (Fig. 5*a*). After approximately 30 min, these ribbons began to move apart and coil into a twisted array. This effect is illustrated by comparing the structures (note arrows) in Figures 5*a* and 5*b*, two photomicrographs taken at 10-min intervals. The coiling is not caused by localized heating induced by the electron beam of the SEM because beam energy is far lower than in the conventional electron microscope. Indeed, coiling of fibers exposed by fracture was noted in samples "aged" outside the instrument at room temperature. The higher magnification photomicrograph in Figure 6 shows the separate ribbons curling away from larger ribbon bundles (note arrows). Regular cross striations were also observed on the inner core ribbons; however, this particular cross texture appeared to resemble a crystallographic pleating rather than a lamellar overgrowth. The individual ribbons varied in approximate width between 1000 and 5000 Å and were estimated to be approximately 200–400 Å thick. The