usual suspension technique. The sectioned specimens were cut with a diamond knife and mounted on a thin carbon supporting film. The electron microscope observations were made without dissolving the embedding plastic of the sectioned specimen in order to preserve the original state of the specimen as far as possible.

The contamination and radiation damage due to the electron beam was minimized by using an anti-contamination device to cool the vicinity of the specimen holder, and by keeping the beam intensity as low as possible. The electron optical magnification was 110000–150000 times, with a small illuminating beam of about 1μ in diameter formed by a pointed cathode. The exposure time was about 10 seconds.

Experimental results

Observation from the direction perpendicular to the fibre axis.

(*a*) *Behaviour of the 4·5 Å fringes corresponding to 020.*

The three kinds of lattice fringe system previously reported (Yada, 1967) were observed in most cases. They are the 4·5 Å fringes corresponding to the 020 reflexion, the 7·3 Å fringes (or those with a half-spacing depending on the diffraction condition) corresponding to 001, and the diagonally crossed two sets of 4·6 Å fringes corresponding to 110. When the incident beam was nearly perpendicular to the fibre axis, these three kinds of fringes were consistently observed in fibrils from all sources, including the synthetic one. For the sample from Coalinga, California, however, it was found that the 4·5 Å fringes along the fibre axis were very often tilted to the fibril edge by a small angle or even up to several degrees. Fig. 1 shows such examples, with drawings illustrating the configuration of the fibrils. The 4·5 Å fringes are tilted by the angles inscribed in the micrograph, in which it is noted that the fringe contrast disappears or becomes very weak periodically, at the places indicated by the arrows. This anomalous contrast is attributed to a moiré effect due to two sets of Bragg reflexions 020 from the segmental lattice planes which are radially disposed with respect to the fibre axis and at the same time nearly parallel to the incident beam. The period D of the fringe disappearance is given by $D = d/2 \sin \alpha$, where d is the fringe spacing concerned, being 4·5 Å in this case, and α is the tilt angle of the fringes to the edge of the fibrils. An estimated value of D is about 50 Å for $d = 4{\cdot}5$ Å and $\alpha = 2{\cdot}5°$, and nearly agrees with the observed value.

It is seen that the image contrast of the side walls of each fibril is nearly uniform and almost continous along the fibre axis, while that of the central void shows variations from place to place. This suggests that the central voids of fibrils are sometimes filled with amorphous material as reported by Martinez & Comer (1964). This phenomenon will be shown later more clearly in Fig. 5.

Fig. 2 shows two electron diffraction patterns from the Coalinga sample, (*a*) one obtained for a fibril showing the parallel fringes, and (*b*) one for a fibril showing the tilted fringes, where the terms 'parallel' and 'tilted' are used to mean the 4·5 Å fringe systems parallel and tilted to the fibril edge respectively. It is seen that the 020 reflexion in (*b*) is split into two spots with a separation of about 5°, which is twice the tilt angle, 2·5°. The *hk*0 spots are also split, while the 00*l* and *h*0*l* spots do not differ appreciably from those in (*a*).

The tilted 4·5 Å fringes and the related splitting of *hk*0 reflexions were subsequently found in all the other samples studied, including the synthetic one. Fig. 3 is a micrograph of a synthetic fibril in which the tilted 4·5 Å fringes are clearly seen with a relatively large tilt angle of 6°. Fig. 4 is an electron diffraction pattern from a synthetic fibril showing the tilted 4·5 Å fringes. It is seen that the *h*0*l* spots are similar to those from the fibril showing parallel 4·5 Å fringes [*e.g.* Fig. 2(*a*)], although the 0*k*0 spots are clearly split, subtending 5° in this case. In Fig. 5 is shown a low magnification image of two adjoining fibrils from the Transvaal and the corresponding selected area diffraction pattern. This diffraction pattern indicates that the 4·5 Å fringes of one of these two fibrils must be tilted and those of the other must be parallel. It is clearly seen in the micrograph that the intra-fibril voids are not always empty, but often filled with amorphous material at relatively regular intervals as mentioned above.

An examination was made of the distribution of the tilt angle of the 4·5 Å fringes of individual fibrils in several samples. The tilt angles were grouped at intervals of 0·5°, which was the lowest value of the tilt angle measurable on the electron micrographs. The histogram of fibrils showing parallel fringes differs

Table 1. *Chrysotile samples from different localities*
(in the order of observation)

Locality	State	Remarks
Quebec, Canada	pulverized, crude No. 1	Jeffrey mine, ref. Yada (1967)
Coalinga, California	ore, leathery sheet	ref. Mumpton & Thompson (1967)
Globe, Arizona	ore, crude No. 1	
Transvaal, S. Africa	ore, crude No. 1	
Tasmania, Australia	ore, crude No. 3	Rennison Bell mine
synthetic Mg-chrysotile	powder	ref. Noll *et al.* (1958,1960)

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