A DIAMOND KNIFE FOR ULTRATHIN SECTIONING

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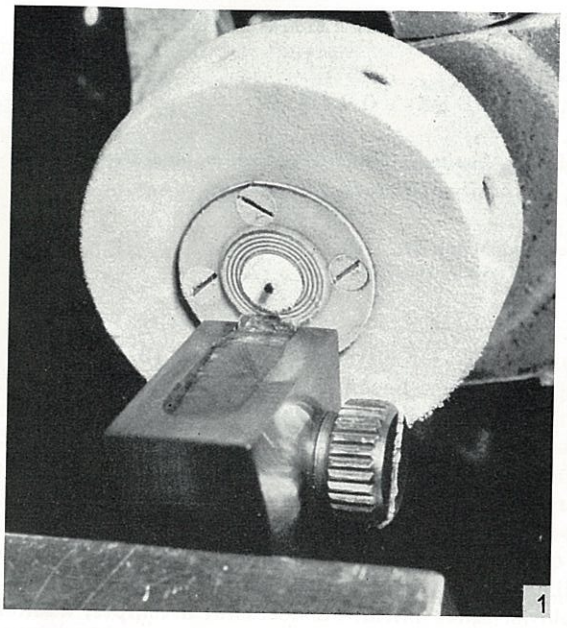
With recent improvements in microtomy for ultrathin sectioning (2, 4) the problem of knife edge quality and sharpness has become of increasing importance. Although special steel and glass knives (3) are generally satisfactory, their edges can be used for a limited time only and hard specimens can not be cut. In an attempt to overcome these drawbacks knife edges of harder crystalline materials have been suggested (1). Diamonds seem particularly suitable for this purpose, since exceedingly sharp cutting edges of unsurpassed hardness can be prepared. In ruling engines for optical gratings diamond edges of extreme sharpness and durability are therefore routinely employed. However, diamond edges are also very fragile and especially sensitive to impacts and small blows. After initial unsuccessful attempts, diamond edges have now been prepared which are of adequate sharpness for cutting ultrathin sections, and maintain this degree of sharpness practically unaltered over long periods of constant use. The natural cleavage planes of certain industrial diamonds (Brazilian Boarts) which are built up of submicroscopic layers can already be used for sectioning, but these edges are as a rule too irregular. By cleavage of these diamonds at certain angles and polishing of the resulting edge with special equipment[1] cutting edges of extraordinary sharpness and regularity can be obtained. In view of the regular crystalline structure of diamond it should eventually be possible to obtain edges of truly molecular thickness. The only limiting factor at present seems to be the grain of the polishing powders, and this can perhaps be overcome by electrical polishing. The diamonds (0.3 carat, 2.5 mm cutting edge; supplied by Industridiamanter A.B.) are set in a suitable alloy and mounted in a special knife holder (Fig. 1) which must be of great stability to avoid detrimental vibrations. After adequate polishing of the edge and determining the optimal cutting angle, serial ultrathin sections (0.5—0.1 μ) of fresh frozen tissues and of methacrylate embedded material have been cut with this knife (Fig. 2). Although still showing numerous knife tracks, these sections are comparable to the best sections obtained in this laboratory with steel and glass knives. The reproducibility of section thickness is satisfactory, and the chemically inert diamond edge is particularly suitable for cutting sections of fresh tissues without introducing contamination. The same diamond knife edge has been in constant use for several weeks without needing resharpening.

[1] The valuable advice of Professor Manne Siegbahn and the expert assistance of Mr. A. Trommer in polishing the diamond edges are gratefully acknowledged.



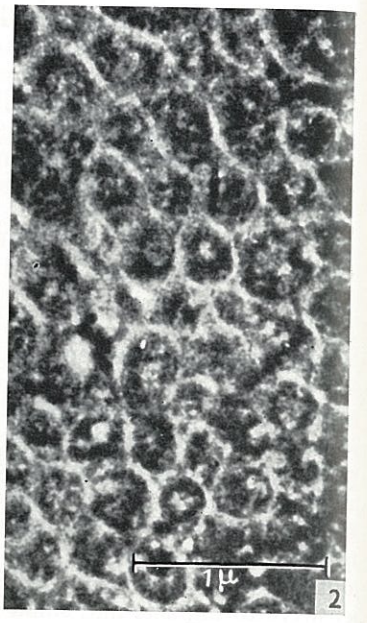


Fig. 1. Diamond knife mounted in special holder of the microtome used for cutting ultrathin frozen sections.
Fig. 2. Transverse section through a bundle of submicroscopic nerve fibres cut with the diamond knife. The thin sheaths of the nerve fibres appear as rings containing the sectioned axon filaments. Magnification: 25000 ×.

Preliminary trials indicate that ultrathin (fragmented) sections of hard materials like bone and certain metals can also be cut with the diamond knife. Improved diamond knives of this type appear to be ideal for ultrathin sectioning and for microtomy in general, since they combine extreme sharpness with utmost hardness and durability. Moreover, diamonds are inherently capable of giving sharper edges than any known material, once the polishing process has been perfected. Details of the process for preparing the diamond knives and the results obtained will be presented in a later publication.

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