A technique for cross-sectioning paper and plastic films

An optical study of the structure of "transfer" layers in a variety of carbon papers, the fibre concentrations in various grades of ordinary paper, and related problems was undertaken. This necessitated the cross-sectioning of paper to obtain an examinable surface, and a low-temperature ultra-microtome technique was developed to this end.

A small piece of the paper or film to be studied was cut from a sheet and placed in the freezing attachment specimen holder of a

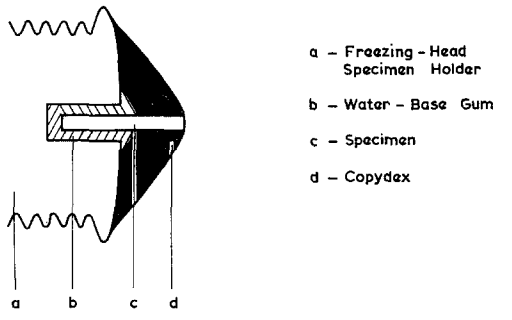

Figure 1 Specimen suitably mounted in holder for cutting.

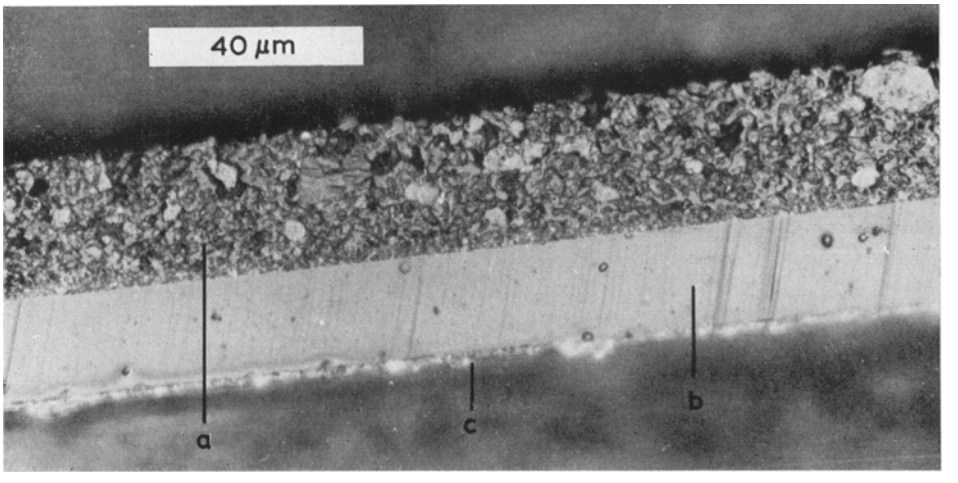

Figure 2 Solvent-carbon layer (a) on plastic backing film (b). Note the section of clearly resolved print layer (c) on the reverse side of the plastic film.

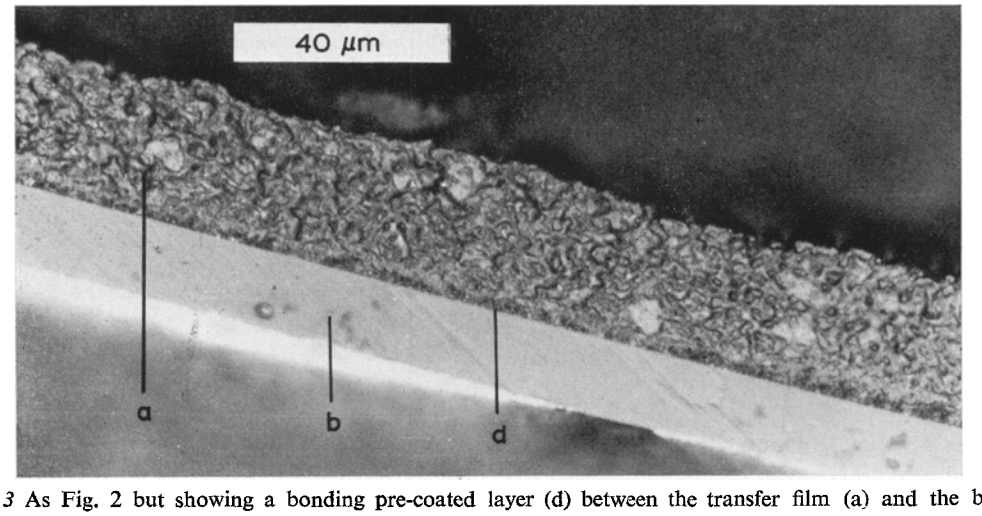

Figure 3 As Fig. 2 but showing a bonding pre-coated layer (d) between the transfer film (a) and the backing film (b).

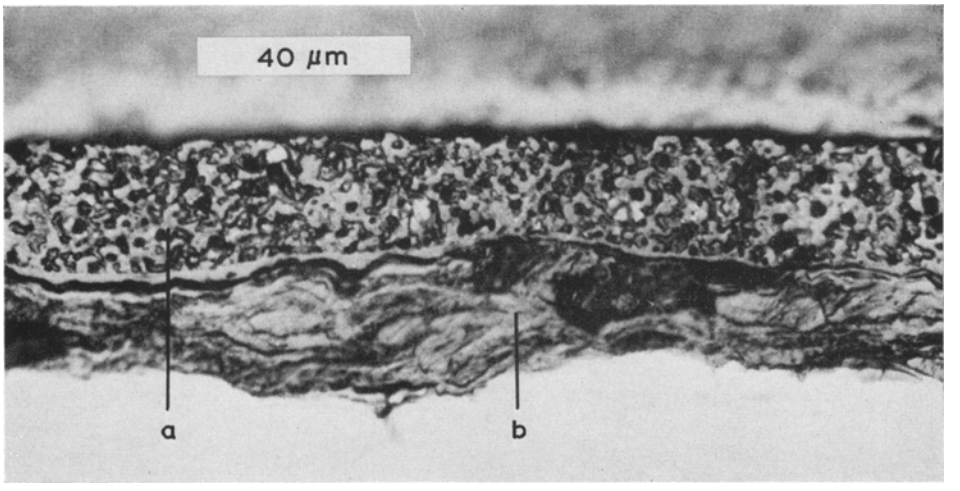

Figure 4 As Fig. 2 but on a paper backing.

Cambridge Huxley ultramicrotome [1], the specimen holder being previously charged with a water-based gum. Care was taken to handle the small specimen only with tweezers and by its extreme edges, in order to avoid deformation of the surface layer.

The liquid gum in the specimen holder held the paper in position for the final mounting operation. This was to surround the whole protruding part of the specimen with a rubber latex adhesive (Copydex) forming it into a conical pyramid suitable for subsequent cutting (Fig. 1). The specimen temperature was lowered to − 165°C, freezing the mounting liquids, whilst the glass knife was maintained at an indicated temperature of −40°C [1].

When equilibrium temperature conditions were reached, surface planing commenced. Coarse cuts were made initially (0.15 μm) until the full width of the specimen was revealed in the Copydex mount. Progressively finer cuts then followed until finally regular cutting was

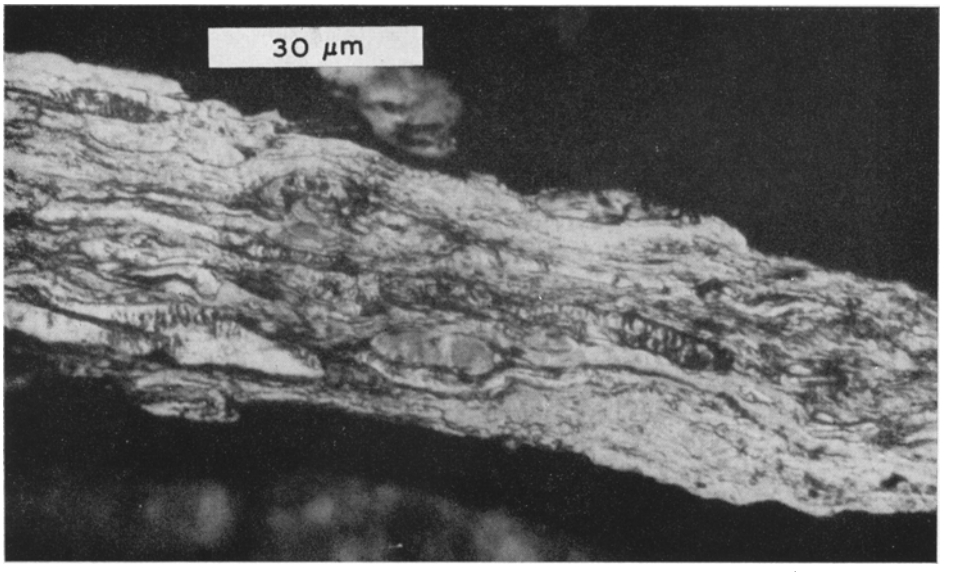

Figure 5 Tracing paper, showing closely packed fibres parallel to the paper surface.

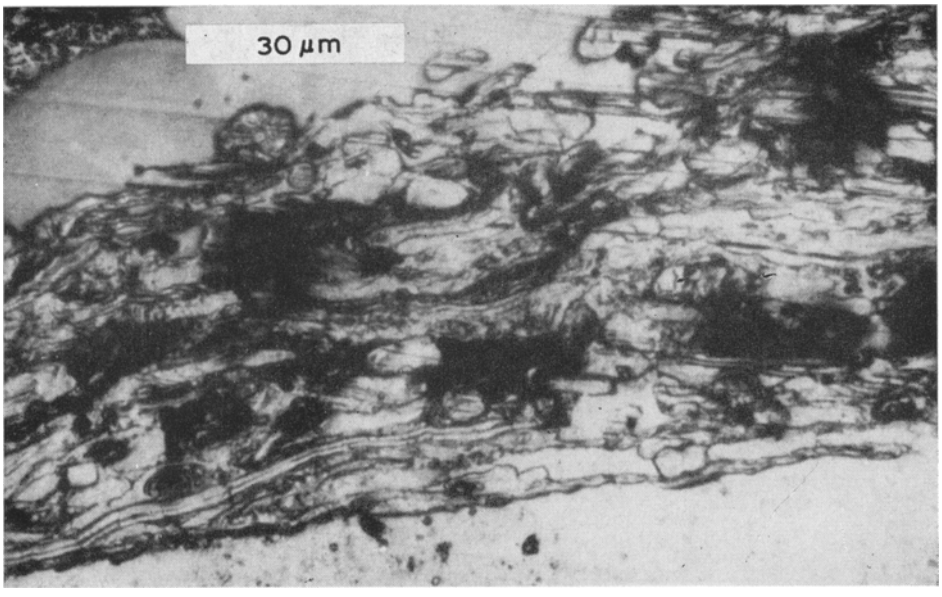

Figure 6 An absorbent duplicating paper showing porous texture.

achieved below 0.05 μm. The specimen was then allowed to warm up to room temperature, removed from the ultramicrotome, placed on a levelling stage and studied with a Zeiss photomicroscope. (Removal of the specimen can be achieved either by the transfer of the Copydex cone to a glass slide, or alternatively, by unscrewing the nosepiece from the freezing attachment and mounting this on a slide.)

The procedure outlined above proved suitable for a range of "carbon papers", with transfer layers on a plastic film or a paper backing. Although ordinary paper could be treated similarly, it was found necessary to protect the surfaces against the condensation of moisture which occurred during "warming up". This was achieved by immersing a strip of the specimen briefly in a polystyrene solution, which gave the paper a thin plastic cover. Mounting and planing could then proceed as described above. Improved visibility of the fibres was achieved if a thin coating of aluminium ($\sim$ 100 Å) was evaporated on to the cut surface.

Carbon papers, both plastic and paper-backed, showed good structural detail when examined with the Zeiss photomicroscope at a magnification of $\times$ 900, (Figs. 2 to 4) any pre-coat layer between transfer film and backing film being clearly visible (Fig. 3). The paper-backed types often revealed that the backing had separated from the applied surface layer and in some cases had broken up completely. This is attributed to "moisture attack" which had been prevented on the ordinary papers by the plastic coating.

Microscopic examination of the latter showed quite clearly the variable fibre concentrations from one paper to another. Fig. 5, for example, shows densely-packed fibres, parallel to the surface, in a tracing paper, whilst Fig. 6 reveals porosity in an absorbent duplicator paper.

Reference

1. E. H. ANDREWS, M. W. BENNETT and A. J. MARKHAM, *J. Polymer Sci. A-2* **5** (1967).

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