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OBSERVATION OF LIQUID TRANSPORT IN THE ESEM

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The environmental SEM (ESEM) allows the observation of liquid and liquid/solid systems in a controlled gaseous environment.[1] In order to study the wetting properties of a wool fiber, or to understand various stages of wool scouring, a system has been devised which allows the transfer of microdroplets onto the specimen surface. A description of the microinjector device together with dynamic observations of liquid transport recorded on video cassette are reported here.

Fig. 1 shows a descriptive diagram of the principle employed to transfer liquids from ambient pressure (about 1000 mbar) into the specimen chamber at hypobaric pressure (about 25 mbar). A small cavity (L) is open to the outside space via two tubes M (with 1 mm inside diameter) so that this cavity can be filled or emptied freely and quickly with a given liquid from the outside. The same cavity communicates with the specimen chamber via a capillary needle (K) with inside diameter about 20 μm and length about 15 mm. When the tubes and cavity are empty, the air flow through the needle is too small to affect the environment in the chamber. For example, a saturation water vapor pressure can be maintained at equilibrium inside the chamber by maintaining a water reservoir which replenishes the vapor leaking through the 400 μm pressure limiting aperture. This equilibrium is not disturbed when emptying or filling the cavity with water. The liquid fills the needle by capillary action and flows at a relatively slow rate when the pressure difference is about one atmosphere. By varying the pressure difference the liquid flow rate can be controlled or stopped. The pressure can be varied, for example, by using a syringe on the end of one of the tubes whilst closing (or opening) the end of the other tube. The needle can be changed by removing the cup-nut (P) together with the sealing gasket (Q) from the body (R). The whole system can be moved via an arm (S) by a suitable mechanism in the X-Y-Z directions independently from the microscope stage movements, so that the tip of the needle can be positioned at the point of observation.

It is possible to form a droplet standing at the tip of the needle and move the object under examination to make contact with the liquid. The subsequent wetting, absorption or reaction of the liquid can be viewed at TV scanning rates and a video recording made for further analysis. With this microinjector system it has been possible to observe the wetting and removal of different components from the surface of greasy (raw) wool fibers. Apart from the specific wool applications for which this device was made, other industrial and scientific investigations can benefit. Video recordings of various liquids and liquid transport will be presented. The flow and absorption of water by paper tissue is shown in Figs. 2, 3, 4,5, and 6 at different instants of time by photographing the TV screen during a playback of a video cassette. The fast changes of configuration of the water droplet can be captured in real time for subsequent study. The ESEM equipped with the present system has created new possibilities for surface physics and chemistry.

References

1. G.D. Danilatos, Scanning 7, 26 (1985).
2. This work was supported by a grant from the Wool Research Trust Fund on the recommendation of the Australian Wool Corporation.

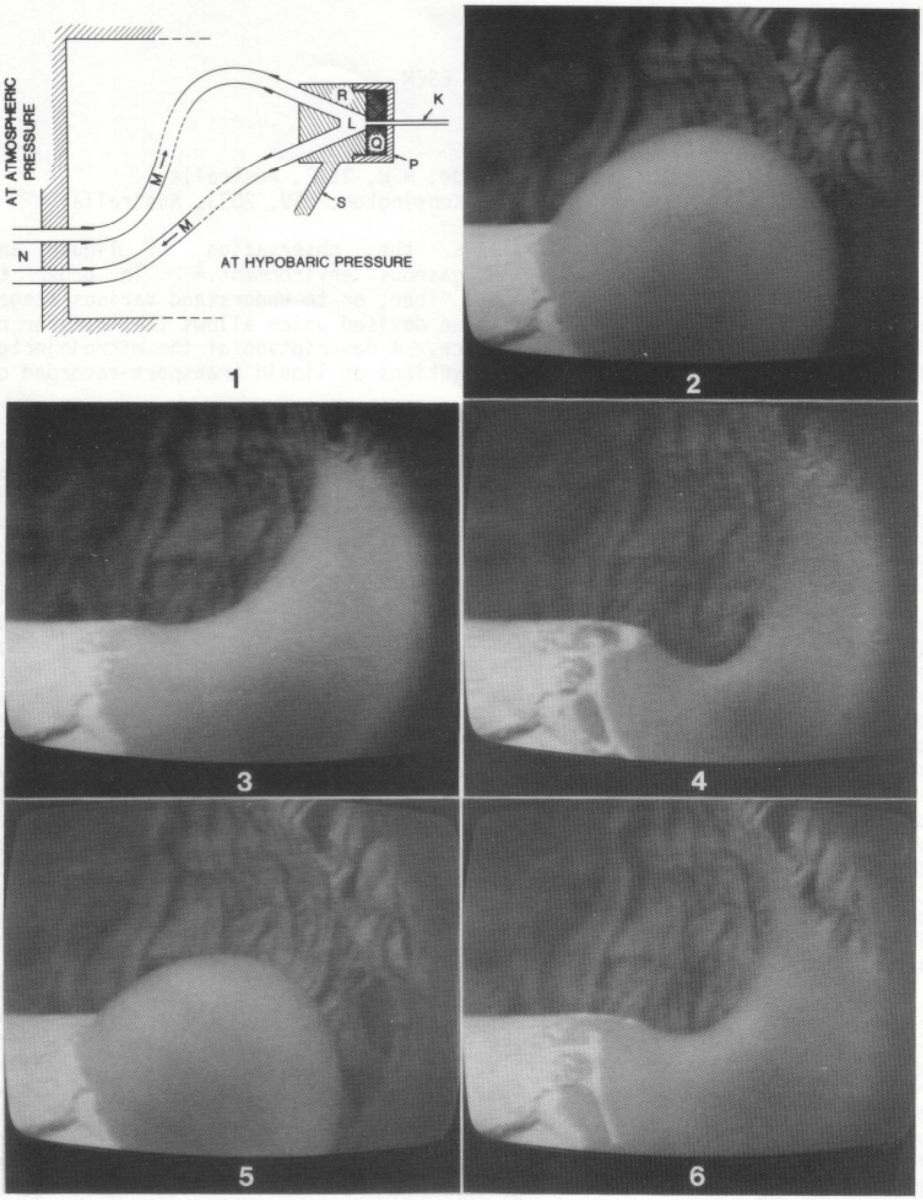

FIG. 1.--Schematic diagram of principal components for microinjector system.

FIGS. 2, 3, 4, 5 and 6.--Photographs from TV screen showing three moments during absorption of water droplet from tip of capillary glass needle. Horizonal field width = 380μm.