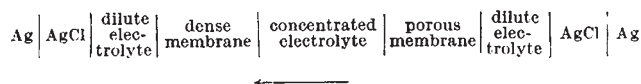


Auxiliary Electrodes in Mosaic Membrane Systems: Porosity Mosaics

ANY heterogeneity in the pore structure of an ionic membrane, such as differences in pore width, charge density at the pore walls, or the sign of these charges, renders the membrane electrochemically a mosaic¹. When such a mosaic membrane is interposed between two electrolytic solutions of different composition its different parts will ordinarily give rise to different potentials. Consequently, the various parts of the mosaic interact electrically; spontaneous local circuits arise, somewhat analogous to those causing metal corrosion¹⁻³.

The small dimensions of the component parts of true mosaic membranes impede their direct physicochemical examination. Macromosaic models have largely overcome this difficulty^{1,4-7}. The examination of macromodels can be greatly furthered by the introduction of a pair of current-carrying symmetrical auxiliary electrodes which do not contribute to the effective electromotive force of the system. This method has been applied recently to the measurement of the electro-osmotic water transport in 'sign of charge' mosaic systems⁷. We want to point out that such auxiliary electrodes are a tool of general usefulness in studying mosaic membranes, and demonstrate this in an additional instance, water transport investigations in 'width of pore' mosaics.

The general approach, technique, and apparatus used were the same as described in detail for a 'sign of charge' mosaic model⁷. The only difference was that, instead of two membranes of opposite charge, two membranes of the same charge but of different porosities were used. The model examined was:



the arrow indicates the flow of the positive current when electronegative, preferentially cation permeable membranes are used. This model is based on the fact that the water transport per faraday is larger across porous membranes than across denser ones³. The anticipated effect in this scheme is the difference between the larger flow (per faraday) across the porous membrane into the concentrated solution and the rather small outward movement across the dense membrane.

In such 'width of pore' models, we determined the rate of volume change of the concentrated solution on open and on closed circuit, and the current; the difference between the two rates is the expected electro-osmosis.

The membranes used were (electronegative) polystyrene sulphonic acid-collodion membranes⁹, the denser ones being permselective and permeable to non-electrolytes having molecular weights less than 100. The more porous ones, prepared by swelling a permselective membrane in 97 per cent ethanol¹⁰, were permeable only to molecules with molecular weights lower than 100,000. The concentration potential 0.1 M/0.01 M across such permselective membranes is +54 to +55 mV for KCl or LiCl; across the more porous membranes it is about +10 to +15 mV with KCl, and differs not much from zero with LiCl. LiCl was chosen as the electrolyte for the model experiments because of the large hydrated size of the Li⁺. In electro-osmosis Li⁺ carries more water per faraday than other univalent cations⁷; also, with LiCl there is a larger difference between the potentials arising across the dense membrane and across the porous membrane than with other uni-univalent salts. The solute concentrations were the same as previously⁷; LiCl was 0.2 M in the more concentrated solution, and 0.002 M in the dilute solution with 0.25 M sucrose added to minimize the effect of normal osmosis.

In one experiment with such a 'width of pore' mosaic model, a current of 1.3 m.amp was obtained; the concomitant electro-osmotic flow was 34 moles of water/faraday into the compartment of the concentrated solution. In another test the current was 1.9 m.amp accompanied by an electro-osmosis of 42 moles of water/faraday.

The results obtained with the 'width of pore' model give additional support, more convincing than that furnished before^{1,4}, to the concept that anomalous osmosis in ordinary membranes is due to heteroporosity². In a true micromosaic the differences in pore size are likely to be considerably less than in our model; this would reduce the electro-osmotic effect. On the other hand, as stressed previously⁷, the linear pathways of the current in micro-mosaic systems are smaller by two or more orders of magnitude, and the sum of the local currents and the concomitant water transport are correspondingly higher. This view of the mechanism of anomalous osmosis is not necessarily incompatible with Schlögl's very ingenious idea concerning this problem¹¹. It does not seem improbable that the two mechanisms might be component parts of the basic mechanism which still awaits quantitative elucidation.

Auxiliary electrodes have now been applied successfully in the study of three different mosaic membrane systems, two previously reported^{5,7} and one presented here. Thus it seems most probable that a variety of other effects in mosaic systems might be studied to advantage by the use of such electrodes. Obvious problems include: the transport of both electrolytes and of co-existing non-electrolytes in 'sign of charge' mosaics with various combinations of permselective and more porous membranes; the transport of electrolytes and of co-existing non-electrolytes in 'width of pore' mosaics.

C. W. CARR

Department of Biochemistry,
University of Minnesota,
Minneapolis.

K. SOLLNER

Laboratory of Physical Biology,
National Institute of Arthritis and
Metabolic Diseases,
National Institutes of Health,
Bethesda, Maryland.

¹ Sollner, K., and Grollman, A., *Z. Elektrochem.*, **38**, 274 (1932).

² Sollner, K., *Z. Elektrochem.*, **36**, 234 (1930).

³ Sollner, K., *Biochem. Z.*, **244**, 370 (1932).

⁴ Grollman, A., and Sollner, K., *Trans. Electrochem. Soc.*, **61**, 487 (1932).

⁵ Neihof, R., and Sollner, K., *J. Phys. Chem.*, **54**, 157 (1950).

⁶ Neihof, R., and Sollner, K., *J. Gen. Physiol.*, **38**, 613 (1955).

⁷ Carr, C. W., and Sollner, K., *Biophys. J.*, **4**, 189 (1964).

⁸ Carr, C. W., McClintock, R., and Sollner, K., *J. Electrochem. Soc.*, **109**, 251 (1962).

⁹ Neihof, R., *J. Phys. Chem.*, **58**, 916 (1954).

¹⁰ Carr, C. W., Anderson, D., and Miller, I., *Science*, **125**, 1245 (1957).

¹¹ Schlögl, R., *Z. Phys. Chem.*, N.F., **3**, 73 (1955).

BIOPHYSICS

An Investigation of Soluble Ribonucleic Acid by Zone Electrophoresis

STRUCTURAL and physical chemical investigations of transfer RNA, whether fractionated or not, in general require that the material be reasonably pure and essentially free from contaminant RNAs of different kinds. Most of the methods at present used for preparation of sRNA from the cell supernatant involve only removal of the proteins, and as Brown has pointed out in a recent review¹, the presence of contaminants in the form of other relatively low molecular weight RNA without transfer function is not to be ruled out. Nor has any method been available for the detection of such impuri-