LETTER

Solid state batteries

Dr Scrosati's interesting and informative review of lithium solid state batteries [1] raises a question of importance to solid state batteries in general. This concerns the need, or otherwise, for a highly conducting electrolyte as a separate entity. Although the answer is implicit in the theory described by Wagner [2] and has been discussed more recently by Kroger [3] nevertheless its significance to the logic of battery design bears further emphasis. Consider the specific example of a lithium/cupric iodide cell in the simple, idealized form of a planar, thin film structure. Initially, lithium will react with cupric iodide to produce a reaction product containing lithium iodide. This reaction will attenuate to a negligible rate in the absence of sufficient electronic conduction or chemical diffusion in the reaction product. On applying an external electronic path between the lithium and the cupric iodide the flow of electrons upsets the balance of inner electrostatic potentials across the system. This in turn produces a gradient of electrochemical potential which gives rise to migration and the production of more reaction product. The particular rate at which this reaction occurs (i.e. the discharge current) combined with an arbitrarily chosen cut-off voltage serve to define a limiting thickness of reaction product of some intrinsic resistivity. The important point to note is that the provision of a separate, highly conducting 'electrolyte' serves no useful purpose; on the contrary it would simply be an additional source of polarization loss.

The concept of a limiting thickness of reaction product, which is most clearly seen in the planar thin film example, is germane to all solid state electrochemical devices which involve ionic reactants or products. It is applicable to all electrode geometries, particularly the three dimensional porous structures copied from conventional battery technology. It seems proper, therefore, to search for electrochemical systems whose reactants and reaction products have the right conduction properties rather than fish in a sea of electrolyte for a red herring.

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References

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[2] C. Wagner, *Z. Phys. Chem.*, **B34** (1936) 309.
[3] F. A. Kroger, 'The Chemistry of Imperfect Crystals', North-Holland (1964).