*Proc. Indian Acad. Sci.* (*Chem. Sci.*), Vol. 112, No. 3, June 2000, p. 378
© Indian Academy of Sciences

# Electrochemical investigations related to solid state magnesium batteries

G GIRISH KUMAR and N MUNICHANDRAIAH
Department of Inorganic and Physical Chemistry, Indian Institute of Science, Bangalore 560 012, India

Investigations leading to the understanding and development of solid state magnesium batteries are considered important, as Mg is free from hazards and is also highly stable and abundant. A gel polymer electrolyte (GPE) of about 100 mm thickness is investigated for electrochemical reversibility of the $Mg/Mg^{2+}$ couple and for characterization of $Mg/GPE/MnO_2$ solid state cells. The GPE consists of polyacrylonitrile, propylene carbonate, ethylene carbonate and magnesium triflate. The composition is optimized in view of the minimum liquid constituent required for gel formation and the maximum specific conductivity ( s). The s of the GPE films follows Arrhenius behaviour and the energy of activation for ionic conduction is in the range 0·13 and 0·16 eV. The a.c. impedance data of the Mg/GPE/Mg symmetrical cells are analysed by fitting the data to the equivalent circuit. The value of the interfacial resistance ($R_i$) of the Mg/GPE interface which is contributed by the surface passive film resistance ($R_f$) on the Mg metal and charge-transfer resistance ($R_{ct}$) of the $Mg/Mg^{2+}$ electrochemical reaction are evaluated. $R_i$ decreases with increase of the cell temperature, while on the other hand, it increases with the ageing of the cell at ambient temperature. Several $Mg/GPE/MnO_2$ cells are assembled and their discharge behaviour studied. Cyclic voltammetric experiments qualitatively suggest reversible behaviour of the $MnO_2$ electrode in GPE medium. The cells are subjected to about 20 charge/discharge cycles. Progressive surface passivation of the Mg negative electrode and poor rechargeability of the $MnO_2$ positive electrode limit cycle life.