Determination of the Electronic and Ionic Partial Conductivities in Several Mixed Conductors Using a Simple AC Method

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Electrical charge can be transported within solids by the net motion of either electronic or ionic species. In materials that are of interest for use as solid electrolytes it is important that charge transport is predominantly related to ionic motion. Minority electronic conduction is generally considered to be deleterious. On the other hand, ionic charge transport is generally not desired in materials such as electronic semiconductors, for it can cause changes in the properties of junctions as well as influencing the concentration of traps and other features of the nanostructure. Between these two extremes are a number of materials that are mixed ionic and electronic conductors. Such mixed-conductors play important roles in a number of different technologies, being employed as oxidation and hydrogenation catalysts, chemical separation membranes, as reactants or inert mixed-conducting matrix components in the microstructure of battery electrodes, and as fuel cell electrodes.

Several DC methods that have been developed over many years to evaluate the separate electronic and ionic components of the total charge transport will be briefly discussed. These include the Tubandt DC method, the DC assymetric polarization technique sometimes called the Hebb-Wagner method, and the DC open circuit potential method

A new method that is relatively simple, and could be advantageous in some cases will be presented. It involves the employment and proper interpretation of low amplitude variable frequency AC measurements, a general technique that is often called impedance spectroscopy. The results of the use of this method on some mixed-conducting materials, including praseodymium oxide and several multicomponent materials with perovskite-like structures will be given, and compared with those obtained by the use of prior techniques.