Bismuth based membranes for oxygen permeation

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Bismuth based oxide materials are well known for their high oxide ion conductivity at moderate temperature. Among these, BIMEVOX materials can be considered as the best oxide ion conductors at moderate temperature, 300-800°C. Because of their high oxide ion conductivity, these materials have been intensively studied as membrane for the electrochemical separation of oxygen from air. When such a membrane is placed in between two compartments with different oxygen partial pressure, oxygen can also naturally migrate from the high oxygen partial pressure room to the low one without any external current. The electrons needed for the oxygen dissociation are provided by the recombination and the oxide flow is equilibrated with an electronic flow in the counter way. This suppose the membrane to be a mixed conductor, either ionic and electronic. It can be made of a pure phase exhibiting mixed conduction or obtained by alloying a pure oxide ion conductor with an electronic phase. In this paper, dense membranes of bismuth-based oxides made of pure ceramic or alloyed with silver, gold or platinum as an electronic phase were prepared from attrition milled powder. BIMEVOX phases, bismuth molybdenum oxide and bismuth tungsten oxide were considered. Their sintering conditions were optimised to obtain membranes with a relative density higher than 95%. Oxygen permeation fluxes were measured in between 600 and 700°C. It was shown these fluxes were usually considerably increased when an electronic phase was added except for BIMEVOX materials alloyed with gold. Oxide diffusion and electronic conductivity control the oxygen permeation in such membranes but kinetics of oxygen transfer at the membrane surfaces can also be a limiting factor. This was confirmed by $^{18}O/^{16}O$ isotope exchange depth profile technique performed on membrane with same composition.

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