Diffusion couple study of the interaction between Cr$_2$O$_3$ and MnCo$_2$O$_4$ doped with Fe and Cu

Manganese cobalt spinel oxides are promising coating materials for the protection of ferritic stainless steel interconnects in solid oxide fuel cell (SOFC) stacks. The interaction between such coatings and the steel is here studied using diffusion couples as a model system. The interaction between MnCo$_2$O$_4$, MnCo$_{1.7}$Fe$_{0.3}$O$_4$ and MnCo$_{1.7}$Cu$_{0.3}$O$_4$ spinels and Cr$_2$O$_3$ was studied in air at 900 °C. In all cases, a reaction layer rich in Co and Cr formed at the interfaces. Using Pt-particles to mark the original interface reveals that the reaction layers grow by diffusion of Co (and Mn) from the spinel oxides to the Cr$_2$O$_3$/reaction layer interface. The growth of the reaction layers followed parabolic kinetics with rate constants of 1.3×10$^{-5}$ μm$^2$ s$^{-1}$ for the MnCo$_2$O$_4$/Cr$_2$O$_3$ couple, 8.6×10$^{-6}$ μm$^2$ s$^{-1}$ for the MnCo$_{1.7}$Fe$_{0.3}$O$_4$/Cr$_2$O$_3$ couple, and finally 1.2×10$^{-4}$ μm$^2$ s$^{-1}$ for the MnCo$_{1.7}$Cu$_{0.3}$O$_4$/Cr$_2$O$_3$ couple.