Oxygen exchange kinetics on Pr-CeO_2 SOFC thin film electrodes measured by optical transmission relaxation (OTR)

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Reducing the operation temperature of solid oxide fuel cells (SOFCs) will aid in extending their durability and lifetime. With decreasing temperature, the barrier to oxygen exchange is a key limitation in achieving high power density. Additionally, impurities, such as silica, on the surface can block active sites for the oxygen reduction reaction, leading to long-term degradation in SOFC performance. In this presentation, we examine the oxygen surface exchange kinetics on $Pr_xCe_{1-x}O_{2-\delta}$ (PCO) thin films using a new *in situ* optical transmission relaxation (OTR) technique, which allows us to study the redox kinetics of the bare surface of the films, i.e., without potentially catalytic electrodes. As PCO reduces or oxidizes, its color changes, giving an indication of the amount of reduction/oxidation as well as the rate of redox. Examples of OTR profiles are shown in Figure 1 for a measurement carried out after a step change in oxygen partial pressure from 4% O_2 to 21% O_2 at 600 °C. Initially, the film completes oxidation within 200 s, as indicated by the change in film optical transmission. However, after 110 hours of aging at high temperature, the time for oxidation is greater than 6000 s, over 30 x longer! This change indicates that a degradation of the surface oxygen exchange kinetics occurred during the measurement. After treating the film with La oxide, deposited by pulsed laser deposition, the redox kinetics are fully recovered, demonstrating a new method to resist electrochemical performance degradation! The origins of the degradation and recovery will be discussed.

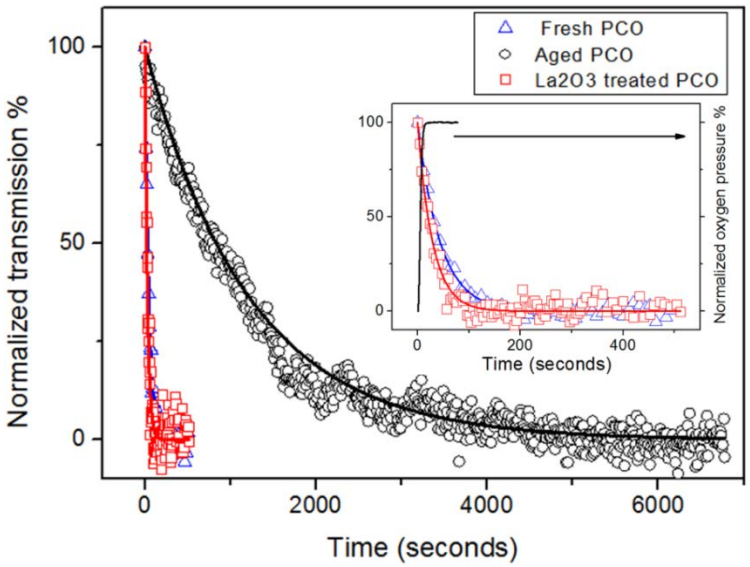

Fig.1 Relative absorption relaxation curve of PCO film measured by OTR. The temperature was 600 °C and the oxygen pressure step was 4 % O_2 to 21 O_2 %. The inset, a magnification of the data, also shows the rapid change of oxygen partial pressure, as compared to relaxation times.