Whereas solid oxide cells (SOCs), which perform dual functions of power generation (fuel-cell mode) and energy storage (electrolysis mode) with high efficiency at high temperatures, are considered a potent candidate for future energy management systems, it is yet far from their practical use due to the fact that the stable long-term operations have not been achieved. Particularly, degradations of oxygen-electrode in the both electrolysis and fuel-cell operations are considered as the most imminent issues that should be overcome. Unfortunately, even the origins and mechanisms of degradation in the oxygen-electrode have not been clearly established due to the difficulties in precise assessments of microstructural/compositional changes of porous electrode, which is a typical form in actual solid oxide cells, and due to the diversities in operating conditions, electrode structure and material, fabrication history, and so on. We simultaneously investigated the degradation phenomena in electrolysis and fuel-cell operations for 540h using identical two half cells composed of a geometrically well-defined, nanoscale La$_{0.6}$Sr$_{0.4}$Co$_{0.2}$Fe$_{0.8}$O$_{3-\delta}$ (LSCF) dense film with a thickness of ~ 70 nm on Ce$_{0.9}$Gd$_{0.1}$O$_{2-\delta}$ electrolyte. Owing to the benefit of well-defined geometry of LSCF thin film, the microstructural/compositional changes in LSCF films were successfully analyzed in nanoscale, and the correlation between the components of electrochemical impedance and the major origins resulting in degradations was clarified. Furthermore, we suggest the most probable degradation mechanisms, and importantly, it is newly suggested that kinetic demixing/decomposition of LSCF, which is not readily observable in the typical porous-structured electrode, are highly probable to affect the both fuel-cell and electrolysis long-term degradations.