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Chemical looping is an efficient method to convert carbonaceous fuel into chemicals (syngas or hydrogen) or heat/electricity with simultaneous CO2 capture. This system employs an oxygen carrier to transfer oxygen, which consists of an active metal oxide and support. Recently, conductive materials have been suggested to be used as the support to improve the redox performance and coke resistance. However, the redox stability of conductive material-supported iron oxide materials after long-term redox reactions has rarely been investigated. In this study, we found that fluorite-type Gd0.1Ce0.9O2-δ (GDC) supported iron oxide showed high reactivity and long-term stability resulting from particle size effect and redox stability of GDC. After 100 redox cycles, the LSF-supported iron oxide showed a loss of mechanical strength and severe fragmentation, whereas the GDC-supported iron oxide exhibited high redox stability. The LSF was fragmented and sintered, whereas the GDC showed inertness. Thus, the conductivity and mechanical properties of the support under redox conditions played a crucial role in the redox stability and reactivity of an iron-based oxygen carrier.