Thermodynamic explanation of the universal correlation between oxygen evolution activity and corrosion of oxide catalysts

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Supplementary Information

In the following, we will reformulate the three basic (electro)chemical processes (1)-(3) for acidic conditions with $H_3O^+_{aq}$ species.

Acidic conditions

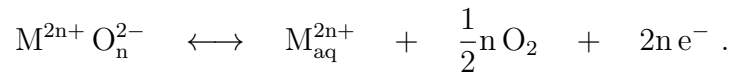1.) Chemical dissolution of the metal oxide without change of the cation oxidation state

$$M^{2n+}O_n^{2-} \quad + \quad 2n\,H_3O^+_{aq} \quad \longleftrightarrow \quad M^{2n+}_{aq} \quad + \quad 3n\,H_2O \ ,$$
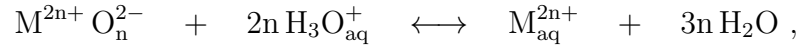
2.) Oxygen evolution reaction (OER) from the electrolyte (water splitting)

$$3\,H_2O \quad \longleftrightarrow \quad \frac{1}{2}\,O_2 \quad + \quad 2\,H_3O^+_{aq} \quad + \quad 2\,e^- \ ,$$

3.) Lattice oxygen evolution reaction (LOER) directly from the metal oxide

$$M^{2n+}O_n^{2-} \quad \longleftrightarrow \quad M^{2n+}_{aq} \quad + \quad \frac{1}{2}n\,O_2 \quad + \quad 2n\,e^- \ .$$

The consequent derivation of the thermodynamic instability of the metal oxide under OER conditions in acidic environment is exactly analogous to the one for alkaline environment.