Understanding The Structure and Properties of The Elusive Non-Stoichiometric Lead Dioxide

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Underutilization of the active material on the positive plate has been a persistent restriction on the performance of lead-acid batteries. Initial utilization of chemically-prepared and PbO\(_2\) phases formed in a battery during charge suggests that the stoichiometries change with cycling\(^1\) and proximity to oxygen evolution. Moreover, the lifetime of the battery is often limited by the ratio of \(\alpha\) and \(\beta\)-PbO\(_2\) and the adhesion between PbO\(_2\) and the underlying Pb current collector. This interface, referred to as the “corrosion layer” is thought to contain lead oxides with intermediate composition between PbO and PbO\(_2\). Similar phases have previously been identified by mass loss or color change during thermal decomposition of PbO\(_2\) to PbO, suggesting at least two phases\(^2, \, 3\). Here, we identify the structure of these phases using multiple in situ analysis techniques. Isolation of PbO\(_x\) phase/s using TGA enabled determination of a PbO\(_x\) structure and further analysis with NMR and XPS to provide Pb oxidation states and Pb environments. Finally, we compare these results to data collected from industrial battery plates.

References

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