The 117th GREEN Seminar

Developing a Kinetic Theory of Electrocatalysts and Enzymes

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The Sabatier principle is a cornerstone of modern catalyst development. It states that catalytic activity can be maximized by tuning the binding interaction between the catalyst and its substrate. However, it is a thermodynamic principle, leading to fundamental limitations in prediction accuracy.

I will first highlight these limitations based on my previous experiments on oxygen evolution catalysts. Then, I will explain my ongoing attempts to realize a post-Sabatier theory through the incorporation of kinetics. In particular, I will propose that the volcano plot may shift depending on reaction conditions such as the overpotential. This shift occurs even for the hydrogen evolution reaction which is the simplest electrocatalytic reaction containing just one intermediate. Furthermore, the mechanism with one reaction intermediate is mathematically identical to the Michaelis-Menten mechanism of enzyme catalysis, and indeed, the theoretical predictions from the kinetic theory matches well with the kinetic parameters of enzymes obtained experimentally. Finally, I will briefly introduce my ongoing attempts to understand not only artificial electrocatalysts and enzymes but networks of catalytic reactions in the environment.

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