

For a heterogeneous electrode reaction, the current and overpotential are dependent of one another. (i) Write the equation that relates the current with overpotential. (ii) What is the name of this equation? (iii) For a heterogeneous electrocatalyst, the current can be activation controlled, mixed controlled, or mass transport controlled. Which current can be analysed by this equation? (iv) Can this equation be directly used to describe the current-over potential relationship of molecular electrocatalysis? Why or why not?

1. Two parameters can be obtained in a Tafel equation: exchange current and Tafel slope. Exchange current is a measure of “intrinsic activity” whereas Tafel slope describes how the current varies with the application of overpotentials. A catalyst has been improved by increasing the number of its active sites. Explain how this improvement affects the exchange current and Tafel slopes.

Many new hydrogen evolution catalysts in acidic solutions based on  $\text{MoS}_2$ ,  $\text{Mo}_2\text{C}$  and  $\text{Ni}_2\text{P}$  have been developed in recent years. To explain their high activity, people calculate the absorption energy of hydrogen atom on these catalysts. (a) Use the mechanism of hydrogen evolution on a heterogeneous catalyst to explain why hydrogen absorption energy is related to the HER catalysis. (b) Propose two methods how you can improve the HER activity of these materials.