Photocatalytic enhancement of thermal catalytic reactions

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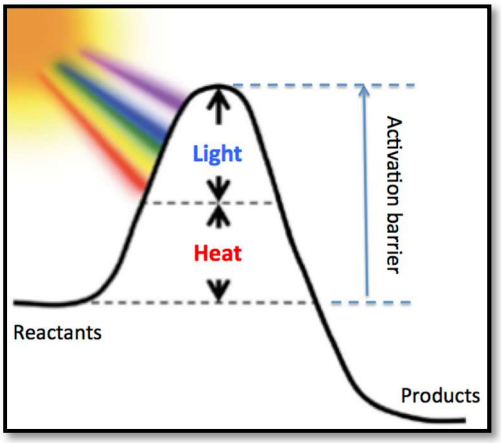
Abstract: Many heterogeneous catalytic reactions require significant energy input to overcome the activation energy barrier. This energy input is generally provided by heating the catalyst bed to high enough temperatures where significant conversion of reactants can be achieved. However, for exothermic reactions, the equilibrium becomes less favorable as the temperature is increased. This raises the question to what extent it may be possible to increase the rates of thermal catalytic reactions in the gas phase by photocatalytic enhancement so that high conversion levels can be reached at lower temperatures where the equilibrium is more favorable.



In this lecture, we explore the interplay between thermal and photocatalytic activation of reactants, with particular emphasis on how photogenerated charge carriers in photocatalytic materials are affected by temperature [1,2]. We discuss how charge carrier lifetimes can be adjusted by modifying radiative and nonradiative charge carrier recombination through appropriate design of photocatalytic materials and reactor systems.

Practical examples include photocatalytically enhanced oxidation reactions on titania-supported metal catalyst and on core@shell catalysts that facilitate the transfer of oxygen ions from the porous shell material to the catalytically active core. For photocatalytically enhanced hydrogen transfer reactions, we evaluate the feasibility of hydrogen generation via vapor phase water splitting and compare it with electrolysis using proton-exchange membranes.

Key words: Photocatalysis, Oxygen transfer, Hydrogen transfer, PEM electrolysis

References

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