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BOOK REVIEW

Oscillating Heterogeneous Catalytic Systems. Edited by M. M. Slin'ko and N. I. Jaeger, Elsevier, Amsterdam, 1994.

This book presents an extensive review of the literature on heterogeneous oscillating reactions, a challenging task in view of the similar recent reviews by Schuth, Henry, and Schmidt (*Adv. Catal.* **39,** 51, 1993) and by Ertl (*Adv. Catal.* **37,** 213, 1990), the latter covering single crystals. The book classifies oscillations according to the level of complexity involved. The simplest level considers a single oscillator or lumped system, the second level corresponds to an array of oscillators as on a single crystal surface, the third level involves polycrystalline surfaces, the next level considers supported catalysts, and the last level involves the catalytic reactor. The book follows this pattern in presenting literature results.

There is a nice introduction (Chapter 2) to the theory of nonlinear dynamic systems with references to the rich Russian literature on this subject. However, few examples connecting these theories with experimental observations are presented, reflecting the literature situation in this regard.

Chapter 3, on CO oxidation on Pt and other group VIII metals, is the most extensive and follows the adopted format nicely, since this reaction has been examined at all the levels of complexity defined by the authors. Even though for this reaction the dynamics on single crystals is better understood, no generic mechanistic view emerges for the other levels of complexity and the connection between oscillations on single crystals at low pressure and at high pressure is not evident.

Chapter 4 summarizes results on the oscillatory behavior of other reactions, although in all cases oxygen either is involved as a coreactant via direct oxidation (of H_2, NO, NH_3, hydrocarbons, alcohols, acids, and ethylene and propylene oxide) or is indirectly contained in one of the reactants (NO, CO, methylamine decomposition in O_2). Here the results are presented mainly for supported catalysts, or in a few cases for reactor level complexity, and no definitive pattern emerges.

One of the most fascinating aspects of the oscillatory behavior of catalytic reactions is in relation to the spatiotemporal structures that have been observed both at the level of single crystals and on supported catalysts. This is perhaps one of the main contributions to catalysis that has resulted from the study of oscillatory reactions. The occurrence of spatiotemporal patterns, even in the most well-defined single crystal surfaces, shows that surface restructuring due to the reaction changes the surface homogeneity, leading to complex dynamic patterns reflecting an underlying inhomogeneous surface. The surface can no longer be considered a passive reservoir of active sites but a dynamic entity highly sensitive to the reaction environment. The mechanism of coupling between local oscillators and the different levels of heterogeneity is presented as a separate chapter (Chapter 6), even though the resulting spatiotemporal patterns are a direct result of this coupling. A brief discussion of chaotic oscillations is also presented in a separate chapter (Chapter 7), but there is no connection with the previous chapters dealing with spatiotemporal behavior or synchronism. This reflects the literature that emphasizes certain aspects of the oscillatory behavior without examining other connected features.

Finally, for the mathematically inclined there is an extensive chapter (Chapter 8) reviewing mathematical models of oscillations. This chapter reviews results for kinetics oscillations, mostly for single crystals and polycrystalline catalysts, for thermokinetics oscillations, for reactor oscillations, and for oscillations on distributed systems including Monte Carlo simulations.

The references are very complete and cover all the main aspects in the study of oscillating catalytic systems. After reading the book I felt, however, the need for more integration to show the interplay of the various phenomena involved in each case. This reflects, however, the lack of integration present in the literature. More understanding will be gained if experimental results carry estimates of the effects of mass and heat transport in the reaction and show whether spatial effects are present. There is an undeniable underlying there in the oscillatory behavior of catalytic reactions. As I read through the various chapters, I often thought I recognized results that we have seen in our work and was amused to find from the reference that the results were from somebody else's work. The ubiquitous presence of oxygen in all the studies is rather telling and it is perhaps the unifying theme, with variations occurring on various scales, depending on the surface under study, that result in different oscillatory patterns. Overall this book is an important summary of the literature of oscillations in heterogeneous systems and it is a necessary reference to have on hand.

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