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The Dark Side of the Interface of Catalysis: The Point of View of Nanomaterials

Nadi Braidy
Sherbrooke University, Canada

Significant progress in the field of catalysis was achieved by the understanding the of principles of chemical reactions and the careful design of reactors. From the catalyst's perspective, progress was typically achieved by optimizing the formulation and synthesis method to maximize selectivity and yield. This type of empirical methodology together with a dose of serendipity ensured a steady stream of catalyst improvements and discoveries.

In recent years, materials science contributed to the field of catalysis using *Operando* analysis tools together with an integrated approach to catalyst's microstructure to relate composition, crystallography and morphology to its performance. This methodology, at the core of the process-structure-property paradigm, have provided the chemist and the engineer with a much broader and deeper understanding of the catalyst behavior during the process and have established the grounds for rational design of novel catalysts.

Here, we will discuss our recent work to understand the complex interplay between the spinel-type catalysts and the reaction media based on the material's side of the interfacial reaction. In particular, we produced several types of metal ferrites ($M_xFe_{3-x}O_4$) using induction plasma reactors and studied their behavior under catalytic conditions. We examine the morphological, chemical and crystalline phase changes occurring in spinels at various stages of the life cycle of the catalyst: synthesis, activation, reaction, and deactivation with advanced characterization techniques (TEM, EXAFS, in-situ XRD). Ultimately, this unique insight provides solid grounds to the development of catalysts and processes for a range of applications.