Special Issue

Smart Catalysis: Evolution, Present State and Future Horizons

Message from the Guest Editor

Smart catalysis represents a rapidly advancing field at the intersection of materials science, nanotechnology, and chemical engineering, offering new possibilities for efficient, selective, and adaptive chemical transformations. Building on the evolution from conventional homogeneous and heterogeneous catalysts, smart catalytic systems incorporate engineered active sites, stimulus-responsive behavior, and multifunctional architectures capable of operating under dynamic conditions. Recent progress has been driven by the development of nanostructured materials, defect engineering, and hybrid organic–inorganic interfaces, and the integration of computational modeling and machine learning for catalyst design and mechanism prediction. Today, smart catalysis plays a pivotal role in energy conversion, environmental remediation, and sustainable chemical production, with applications ranging from photocatalytic water splitting to CO2 reduction and advanced oxidation processes. Looking ahead, future breakthroughs are expected to include autonomous self-regulating catalysts, sensor-integrated catalytic platforms, and programmable materials that adapt to real-time reaction environments.

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