

Measuring Transient Chemistry Distributions Inside Automotive Catalyst & Engine Systems

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The overall performance of automotive catalyst and engine-system components is often dictated by performance distributions within these devices. Generally, most chemical reactors have internal distributions, whether these reactors are complex Lean NO_x Trap (LNT) catalysts with transient reaction distributions, or non-reacting gas mixing EGR systems. These variations can be indicative of the basic chemistry and physics controlling the reactor, or more mundane engineering issues like flow occlusion from out-of-spec or miss-assembled components. Intra-reactor variations like gas composition, temperature, local sulfur poisoning create corresponding intra-reactor performance distributions indicative of the underlying detailed chemistry. Transient intra-reactor distributed measurements provided detailed insights into how the local chemistry evolves throughout the device. This in turn clarifies the understanding of how these devices actually perform, why they fail, and how to design and control these devices to achieve improved performance and robustness. These advances enabled by the rich detail of intra-reactor analysis are obscured by analysis based on effluent measurements. The presentation will describe the SpaciMS (Spatially Resolved Capillary Inlet Mass Spectrometer) which was developed to study transient chemistry distributions within operating LNT catalysts. The practical insights available via intra-reactor analysis will be demonstrated through SpaciMS application examples including: ammonia formation and utilization during LNT catalyst regeneration, and assessment of EGR-air mixing hardware.