177e Local Dosing for the Control of Spatiotemporal Patterns

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Local manipulation and control of spatiotemporal concentration patterns is a subject of increasing interest. Control of a heterogeneous catalytic reaction has previously been demonstrated for CO oxidation on Pt, where a laser was used to locally heat the catalytic surface and thereby alter the surface reactivity.[1] Another method for controlling the surface reactivity is to locally control the gas phase composition near the catalyst surface, a method that we demonstrate for the first time.

In our experiments, local surface coverage on Pt(100) is altered by dosing gases through a ~30 microns diameter capillary positioned just above the catalyst surface. The catalyst is mounted inside a continuously pumped vacuum chamber where the pressure is maintained near $1x10^{-4}$ Torr during typical experiments. Ellipsomicroscopy for surface imaging (EMSI), an optical technique that allows contrast between areas of the surface with different adsorbate coverages, is used to continuously monitor the effects of the local dosing. The dosing system causes an area of the surface ~10-100 microns in diameter to become saturated with the dosed species. A spot of this size can easily be imaged by EMSI, which has a 1 mm^2 field of view. The size of the affected area can be controlled by adjusting the doser-to-sample distance or the total pressure inside the reactor. The doser itself is mounted on an x-y-z translation stage so that the dosed spot can easily be moved around the catalyst surface.

Investigations using our dosing apparatus have been performed during CO oxidation on Pt(100), a system that has already been shown to exhibit a wide variety of nonlinear behavior.[2] The doser enables us to observe the behavior of self-sustained spatiotemporal patterns when perturbed by locally dosed CO, O_2, or another gas. We also demonstrate that spatiotemporal patterns can be induced by dosing alone.

[1] J Wolff, AG Papathanasiou, HH Rotermund, G Ertl, X Li, and IG Kevrekidis, J. Catal., 216 (2003) 246. [2] T Lele, and J Lauterbach, Chaos, 12 (2002) 164.