Controlling spatiotemporal chaos in a surface chemical reaction by time-delay autosynchronization

C. Beta
Fritz-Haber-Institut (MPG), Berlin, Germany.

A global feedback scheme is implemented experimentally to control chemical turbulence in the catalytic CO oxidation on a Pt(110) single crystal surface. The reaction is investigated under UHV conditions by means of photoemission electron microscopy (PEEM). We present results showing that turbulence can be suppressed by applying time-delay autosynchronization (TDAS). Hysteresis effects are found in the transition regime from turbulence to homogeneous oscillations where complex spatiotemporal patterns can be observed. For efficient suppression of turbulence, there is an optimal value of the delay time in the feedback scheme for which the feedback signal is reduced considerably. However, near this value, an instability with respect to the oscillation period is observed.

Numerical investigations on the model of the catalytic CO oxidation on Pt(110) show a similar behaviour. The jump in the oscillation period at the optimal delay time can be understood in terms of analytical investigation of a phase equation with time-delay autosynchronization. At this point, a supercritical pitchfork bifurcation of the oscillation frequency occurs for increasing feedback intensity.

For the phase dynamics, this instability may be evaded by reversing the sign of the feedback signal. In the model of the catalytic CO oxidation on Pt(110), however, a reversed sign of the feedback term causes the occurrence of period doubling near the optimal delay time.

Collaborators: M. Bertram, A.S. Mikhailov and H.H.Rotermund