Keramische Werkstoffe und Bauteile
Prof. Dr.-Ing. Kurosch Rezwan
Fachbereich 4 - Produktionstechnik

Graduiertenkolleg MIMENIMA
DFG GRK 1860

Guest Seminar 06.01.2014 / IW 3, room 0330 14 .00 – 16.00 Uhr

Title : Remote control of reaction-diffusion processes in porous media

Speaker: Professor Dr. Frantisek Stepanek

Chemical Robotics Laboratory, Department of Chemical Engineering, Institute of Chemical Technology, Prague, Czech Republic

Abstract:
The ability to control the rates of chemical or biochemical reactions at length-scales comparable to those of single-cell organisms or their sub-cellular compartments would be desirable in a number of situations, ranging from fundamental studies of transfer phenomena to applications such as controlled delivery of actives from functional materials in the pharmaceutical, food, personal care or crop protection products. Established strategies for the control of chemical reactions known from the macroscopic world, such as control of temperature, the addition rate of reactants, or the availability of a catalyst have been applied to autonomous micro-scale systems called “chemical robots”. A chemical robot is an internally structured microparticle consisting of a semi-permeable membrane that regulates molecular transport between the interior and the surroundings, a system of stimuli-responsive internal compartments that store and release reactants, immobilised enzymes or catalysts for facilitating chemical reactions, and magnetic nanoparticles that act as susceptors and enable the receiving of remotely sent radiofrequency signals.

The talk will present an implementation of chemical robots based on soft hydrogel bodies produced by the drop-on-demand inkjet printing method, with internal storage reservoirs formed by phospholipid vesicles (liposomes) and immobilised enzyme (laccase) as a catalyst. Super-paramagnetic iron oxide nanoparticles that dissipate heat when exposed to alternating magnetic field in the radiofrequency range are used as susceptors that facilitate the control of local temperature, which in turn controls the diffusion rate of reactants from liposomes and thus the local reaction rate. The talk will cover fabrication methods for the bottom-up assembly of chemical robots, their structural and functional characterisation. Several scenarios will be presented, including simple one-off release of a pre-synthesised chemical payload, repeated on/off release, and finally repeated starting, stopping and restarting of a local chemical reaction that produces a chemically unstable product. The flow and deposition of chemical robots in porous media observed by MRI in the context of spatially specific delivery of actives will also be discussed.