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Name	Maarten Roeffaers
University	Catholic University of Louvain (B)
Department	Centre of Surface Chemistry and Catalysis and the Laboratory for Nano and Molecular Materials
PhD Supervisor	Prof. Dr. D. de Vos

We investigated whether fluorescence microscopy can answer the need for new spectroscopic characterization techniques in the field of catalysis. Therefore during this Ph.D. project several fluorescent assays were developed that make it possible to study the various elementary steps in catalysis (adsorption, diffusion, catalytic turnovers). This way spatially resolved structure-activity relationships could be established at the level of individual features of catalysts, such as crystals, crystal faces or even individual catalytic sites. For the first time, crystal-face dependent catalysis was demonstrated for individual LDH and zeolite catalysed reactions could be assigned to specific poresystems. Assays with dedicated probes provided accurate and unique insights in the structure of complex zeolite materials. Furthermore a new nanoscopic approach, based on the intrinsic activity of the catalysts, was developed making it possible to push forward the spatial resolution of fluorescence microscopy at least one order of magnitude. We thus proved the versatility of fluorescence microscopy as a new tool in catalytic research.

Efficient chemical processes are very important for the development of a sustainable economy. Green chemistry strongly relies on the design of efficient catalyst, hence gaining detailed insight into the activity of these complex materials has been the aim of many in situ characterization techniques. However, not all systems can be studied with traditional techniques. During his Ph.D. project, Maarten Roeffaers pioneered the use of fluorescence microscopy in catalysis research. He developed several fluorescence based assays to study the various elementary steps in catalysis at very small scales and with high sensitivity. With this innovative approach he could unravel various steps of the complex catalytic cycle that were previously hidden for other techniques.