Recent Advances in Spectroscopic and Calorimetric Process Analysis for Microfluidic Processes

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In the past years, microfluidic processes have gained considerable importance in the optimisation and intensification of chemical reactions. Most of this gain is due to significant improvements in heat and mass transport achievable in microstructured reactors. Moreover, many chemical processes offer significant scope for improvement through detailed analysis of the physical-chemical processes on which they are based. The data gained through this analysis can be used to target and optimise specific reaction steps, achieve consistent product quality and finally reduce process costs. However, in industrial practice it is often difficult or even impossible to install and implement process analysis on-site, for technical, economic or safety reasons. Continuously operated microreaction technology and corresponding microfluidic processes offer a solution, replicating technical processes on a small scale and monitoring them in high temporal and spatial resolution with the help of adapted process analysis.

Here, we report on the development of spectroscopic and calorimetric process analytical tools for the realtime monitoring of chemical reactions in microfluidic processes. For example, fast and miniaturized spectroscopy is adapted as inline or online process analysis to allow simultaneous investigations in different spectral regions (Infrared, Raman, UV/Vis/NIR). Moreover, modern imaging techniques make it possible to monitor chemical processes at various measuring points simultaneously. At the heart of the calorimetric measurement systems are miniaturised thermoelectric sensor arrays for the localised, quantitative characterization of heat flows and reaction enthalpies. These data are used to obtain thermokinetic and safety information on the observed chemical process.

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