

CHARACTERIZATION OF A MICROFLUIDIK CHIP USING μ -FREE-FLOW ELECTROPHORESIS (μ -FFE)

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Abstract

Purpose - The poster deals with free-flow electrophoresis (FFE). The task was the planning and implementation of a μ -FFE test stand for characterization of a chip, as well as the performance of the characterization features. The project work aims to apply the laboratory separation technology to new questions with small molecules as well as to ions, while taking the step toward miniaturization down to the lab-on-a-chip scale. In the miniaturized form, the free-flow electrophoresis is characterized by significantly faster separations in continuous operation and greatly reduced chemical consumption, as well as the cleaning and examination of very small sample volumes.

Design/methodology/approach – First, the separation dependence of the electrophoresis was investigated as a function of different buffer solutions of different pH values (6.88, 7.00 and 7.50), of different electrode materials, and of the applied voltage, which was in the range of 0V and 350V. In order to find out how much the separation behavior is influenced by the electrode material and buffer solution, three experiments with different electrode wires (platinum, tungsten and titanium wire) and buffer solutions (phosphate buffer and acetate buffer) were carried out and integrated into the ZEONOR chip for the experiments. Second, many findings in the literature show that gas bubbles formed at the electrodes substantially affect the separation efficiency of the experiments. Therefore transporting the gas bubbles out of the capillary system was attempted by modifying the parameters of the experiment. We tried to find a way to circumvent the gas bubble problem by varying the parameters of the pumps, the pH of the buffer, the concentration of buffer additive (i.e. surfactant) and the buffer type. Primarily, the parameters of the buffer (pH values and surfactant concentration) and the suction device (flow rate) have been changed. Furthermore, we tried to remove the gas bubbles through a new chip alignment. For this purpose, the chip was raised by 90° to a vertical position by means of a holder to allow the outlets to point upwards to let the gas bubbles escape.

Findings - In order to successfully implement these experiments a special structure for the separation of dyes (methylene blue and SPADNS) on a μ -FFE chip was developed and characterized. To get the gas bubble problem under control, platinum, tungsten and titanium electrodes were tested for this purpose, but did not lead to any improvement. Furthermore, the results with the new chip alignment of the chip showed no significant improvement to the gas bubble problem as well. However the use of different pH values, and optimization of the surface tension increased the reproducibility and the separation results of the μ -FFE. It was shown that the phosphate buffer significantly influences the separation depending on the pH value. For phosphate buffers of a pH of 6.88 and 7.50, a poorer separation was observed compared to a pH of 7.00. The graphs shown in the poster demonstrate that the separation of the analyte occurred in the chip during the electrophoresis indicated by the number of chambers. Particularly at high voltages (>250V), the different pH values showed a stronger influence on the separation performance. At high voltage, the separation performance was severely degraded for all pH values except that of 7.0 due to the formation of gas bubbles. At pH 7.0, a separation could be obtained with voltages up to 350V. In order to investigate the applicability and stability of the experiments at different voltages, the stability of the test series was determined as a function of the flow rate in the separation chamber. The results show that the analyte is stable up to a flow rate of 2 ml / h. The analyte band becomes too broad at flow rates above 2 ml / h and thus adversely affects the result. In the presence of surfactant buffer additive, flow rates of 5 ml / h to 20 ml / h could normally be operated and a stable sample flow in the separation chamber could be used.