Microfabricated pillar array columns for liquid chromatography

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Nowadays, there is an increasing demand for better analytical tools in the -omics fields (genomics, proteomics, metabolomics,…), where ever increasing numbers of minimal sample volumes need to be analyzed and quantified in shorter time lapses. Since the performance of a chromatographic bed is extremely sensitive to the bed homogeneity, the present work uses microfabrication techniques from the microelectronics industry to produce ordered pillar array beds that are perfectly homogeneous. This approach allows to combine the advantages of a perfectly ordered packing structure with the numerous advantages of miniaturization, including reduced reagent consumption. In the present thesis, it is demonstrated that the currently existing microfabrication techniques are refined enough to achieve the theoretical performance limit. Applying a hydrophobic monolayer to the outer surface of the pillars, fast reversed-phase separations of a synthetic mixture could be conducted at different mobile phase velocities. As a result, it is concluded that these microfabricated columns could yield much faster separations compared to the conventional packed bed. Subsequently, real-world biological mixtures originating from two different bacterial strains are separated while revealing 15 components in less than 1 minute, illustrating that these columns can be useful for practical applications. The presented microfabrication strategy could also be used to conduct fundamental band broadening studies by designing and testing two different channels displaying a different degree of heterogeneity. In addition, it is also illustrated that the flat format of these pillar array channels is ideally suited to make detailed in-situ video recordings of the eddy-dispersion phenomenon.