Micro-fabricated pillar array columns for liquid chromatography: from theoretical concept to an advanced tool for solving (real-life) complex separation problems.

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In the past decade, micro-pillar array columns (PAC's) have been introduced, first as a theoretical concept, and later in the form of proof-of-principle devices, as a means to perform chromatographic separations with a higher efficiency and/or speed than possible with the traditionally packed bed columns.

In the present study, it was investigated how far the concept can be pushed in terms of separation speed and efficiency when the most advanced and state-of-the-art etching techniques are being used to produce the PAC's. It was found that attempts to improve the speed and efficiency by shrinking the diameter of the pillars and the size of the through-pores very rapidly run into machining tolerance limits. Another impediment in the use of PAC's is that they produce such small peak volumes that their performance is very prone to extra-column band-broadening when used in real-world instruments. The range of applications where the machining tolerances and the extra-column band-broadening poses the least problems is that of very high efficiency separations, where relatively large pillars and column lengths are needed. Creating a 3 m long column, a total plate count of over 1 million theoretical plates was realized in 20 minutes. In addition the PAC concept has also been used to push the performance limits of hydrodynamic chromatography (HDC) separations of micro- and nano-particles, as well as to investigate more fundamental flow phenomena, such as the occurrence of viscous fingering.

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