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Recent advances of in-tube solid-phase microextraction

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HIGHLIGHTS

- In-tube solid-phase microextraction (SPME) is green approach to sample preparation
- Review of operational devices used for in-tube solid-phase microextraction (SPME)
- Review summarizing the recent trends in chromatographic coupling
- Report on recent advances in new extractive phases
- Couplings and new sorbents as functions of the fields of application

ABSTRACT

In-tube solid-phase microextraction (SPME) is ideally suited to developing green extraction by combining miniaturization, automation and reduction of solvent consumption. SPME has been used for the analysis of environmental, biological, and food samples, and numerous works have shown the benefits of using SPME. However, for full development of in-tube SPME, effort is still needed to overcome limitations, such as low extraction efficiency, selectivity and mechanical stability. To achieve these objectives, research on in-tube SPME is mainly focused in two scenarios:

- (1) the coupling of in-tube SPME with new chromatographic modalities, such as miniaturized liquid chromatography; and,
- (2) the preparation of new extractive phases.

This review describes the recent advances in in-tube SPME coupled to different chromatographic systems and their main applications. Moreover, we give an overview of the developments in the preparation of new in-tube SPME extractive phases, highlighting the principal areas of application.

Keywords: Bioanalysis Capillary coating Environmental analysis Food analysis Green extraction In-tube solid-phase microextraction Miniaturized liquid chromatography Molecularly-imprinted polymer Monolithic capillary column Nanoparticle-based coating

Abbreviations: AAm, Acrylamide; CapLC, Capillary liquid chromatography; CNT, Carbon nanotube; DAD, Diode-array detector; DART-MS, Direct analysis in real time mass spectrometry; ESI-QTOF, Electrospray ionization-quadrupole time-of-flight; FD, Fluorescence detection; FGO-PD, Functionalized graphene-oxide-polydopamine; GAC, Green Analytical Chemistry; IFN $\alpha 2a$, Interferon $\alpha 2a$; IL, ionic liquid; In-tube SPME, In-tube solid-phase microextraction; LOD, Limit of detection; γ -MAPS, 3-methacryloxypropyltrimethoxysilane; MBA, N,N'-methylenebisacrylamide; Lyz, Lysozyme; MIP,

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