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Review

Newest applications of molecularly imprinted polymers for extraction of contaminants from environmental and food matrices: A review

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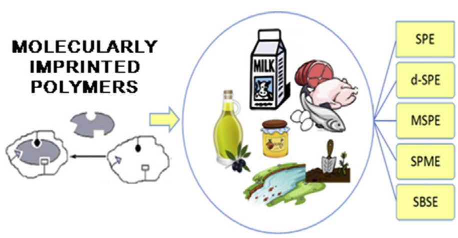
HIGHLIGHTS

- Novel applications of molecularly imprinted polymers (MIPs) to sample preparation.
- Preparation and application of new MIP composites.
- Physical-chemical properties and analytical performance of MIP sorbents.
- Selective extraction of contaminants from complex matrices.
- Analytical procedures for enrichment/cleanup of food and environmental samples.

GRAPHICAL ABSTRACT



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ABSTRACT

This paper presents an overview of the recent applications of molecularly imprinted polymers (MIPs) to sample preparation. The review is thought to cover analytical procedures for extraction of contaminants (mainly illegal/noxious organic compounds) from food and environmental matrices, with a particular focus on the various pre-concentration/cleanup techniques, that is offline and online solid-phase extraction (SPE), dispersive SPE (d-SPE), magnetic SPE (MSPE), solid-phase microextraction (SPME) and stir-bar sorptive extraction (SBSE), applied before instrumental quantification. The selectivity and extraction efficiency of MIP-based sorbent phases are critically discussed, also in relation to the physical-chemical properties resulting from the synthetic procedures. A variety of molecularly imprinted sorbents is presented, including hybrid composites embedding carbon nanomaterials and ionic liquids. The analytical performance of MIP materials in sample preparation is commented as function of the complexity of the matrix, and it is compared to that exhibited by (commercial) aspecific and/or immunosorbent phases.

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Acronyms

2,4-DCP	2,4-dichlorophenol
2,4,6-TCP	2,4,6-trichlorophenol
2,6-DCP	2,6-dichlorophenol
2-CP	2-chlorophenol
4-CP	4-chlorophenol
AA	acrylic acid
ABPA	3-amino-1-propanol acrylate
ACN	acetonitrile
AIBN	2,2-azoisobutyronitrile
AM	acrylamide
APTES	3-aminopropyltriethoxysilane
ASE	accelerated solvent extraction
BSA	bovine serum albumin
BPA	bisphenol A
C[4]	5,11,17,23-tetra-*tert*-butyl-25,27-dicyanomethoxyl-26,28-dihydroxy calix[4]arene
CAR	carboxen
CE	capillary electrophoresis
CNTs	carbon nanotubes
CRP	controlled/living radical polymerization
CW	polydimethylsiloxane carbowax
DCM	dichloromethane
DMF	dimethylformamide
DMSO	dimethylsulfoxide
d-SPE	dispersive solid-phase extraction
DVB	divinylbenzene
EAMA	*N*-(2-aminoethyl)methacrylamide
ECD	electron capture detection
ECL	electrochemiluminescence
EDMA	ethylene dimethacrylate
EF	enrichment factor
EGDMA	ethylene glycol dimethacrylate
ELISA	enzyme linked immunosorbent assay
EtOH	ethanol
FA	formic acid
FD	fluorescence detection
FID	flame ionization detection
FPD	flame photometric detection
FQ	fluoroquinolone
GC	gas chromatography
GMA	glycidylmethacrylate
GO	graphene oxide
HAc	acetic acid
HEMA	2-hydroxyethylmethacrylate
HLB	hydrophilic–lipophilic-balanced reversed phase
HPLC	high performance liquid chromatography
HRCS-AAS	high resolution continuum source atomic absorption spectrometer
IF	imprinting factor
IL	ionic liquid
KH570	3-methacryloyloxypropyltrimethoxysilane
LIF	laser-induced fluorescence detection
LLE	liquid-liquid extraction
MAA	methacrylic acid
MAC	methacryloylchloride
MCX	mixed-mode strong cation exchange reversed phase
MeOH	methanol
MIP	molecularly imprinted polymers
MISPE	molecularly imprinted-based solid-phase extraction
MPS	3-methacryloxypropyltrimethoxy-silane
MS	mass spectrometry
MSPE	magnetic solid phase extraction
MTMS	methyltrimethoxysilane
NIP	not imprinted polymers
NOBE	*N*,*O*-bismethacryloylethanolamine
NPD	nitrogen phosphorus detector
PA	poly(acrylate)
PBS	phosphate buffer saline
PCB	polychlorinated biphenyls
PCP	pentachlorophenol
PDMS	polydimethylsiloxane
PMMA	polymethyl methacrylate
POSS	polyhedral oligomeric silsesquioxane
PP	polypropylene
PS	polystyrene
PVA	polyvinyl alcohol
RAFT	reversible addition-fragmentation chain transfer
RAM	restricted access material
SBSE	stir-bar sorptive extraction
SERS	surface-enhanced Raman spectroscopy
SPE	solid-phase extraction
SPME	solid-phase microextraction
TBA	tetra-*n*-butylammonium hydrogen sulphate
TEOS	tetraethoxysilicate
TFA	trifluoroacetic acid
THF	tetrahydrofuran
TRIM	trimethylolpropanetrimethacrylate
VP	vinylpyridine.