PAL SYSTEM
Ingenious sample handling

PAL SPME Arrow
The Better SPME

PAL SPME Arrow:
The new dimension of SPME

PAL SPME Arrow
The new dimension for Solid-Phase Micro Extraction

SPME has become one of the most widely used extraction technologies for environmental, food and clinical analyses. It is well suited for automated sample preparation resulting in reduced time per sample, less sample manipulation and solvent consumption. However, the technology remained almost unchanged with some significant drawbacks, such as the limited mechanical stability and small phase volumes of the fibers.

The PAL SPME Arrow (patent pending) is a new technology for micro-extraction, combining trace level sensitivity with high mechanical robustness. The PAL SPME Arrow has an outer diameter of 1.1 or 1.5mm, resulting in large sorption phase surfaces and volumes. The arrow-shaped tip allows smooth penetration of vial and injector septa. In contrast to traditional SPME fibers, the Arrow design fully protects the sorptive material, minimizing adverse influences and loss of analytes during transfer processes.
With the PAL RTC and RSI the SPME Arrow sampling is fully automated leading to high productivity.

The figure below shows the dimension of a PAL SPME Arrow 1.5 mm (a), a PAL SPME Arrow 1.1 mm (b) and a SPME Fiber (c) in comparison.

What Better SPME means

Bigger surface,
faster extraction.

More sorption phase,
superior sensitivity.

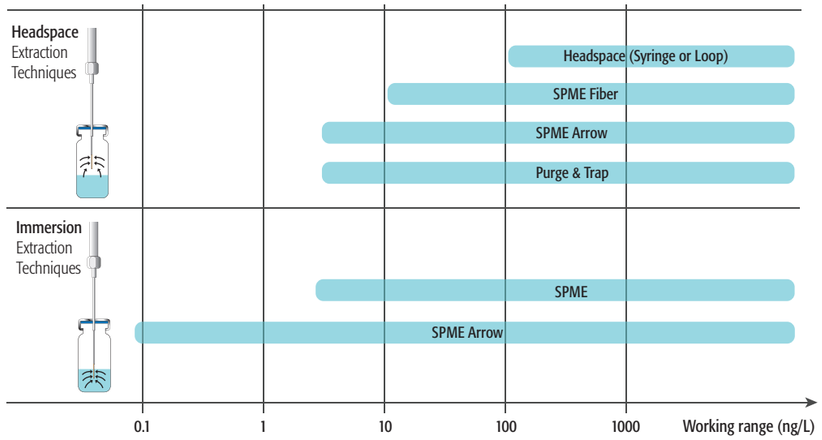
Optimized geometry,
greater robustness.

2 x higher sample throughput.

Up to 10 x more sensitivity - wider linear range.

PAL SPME Arrows last at least 2 x longer.
Injector septa last at least 2 x longer. Lower running costs.

= 2 x productivity



Better SPME

- Adaptation of existing SPME methods is straightforward
- PAL SPME Arrow works well for headspace and immersion extraction
- With the wide selection of sorption materials (cf. page 10) a wide variety of compounds are now amenable to SPME
- The PAL SPME Arrow is an ideal field sampling device

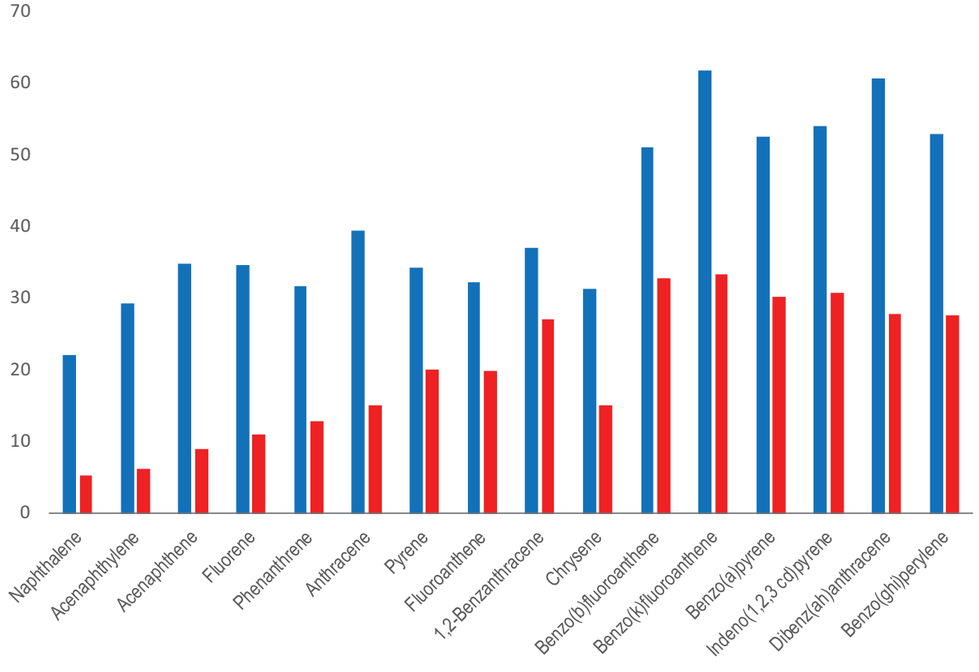
PAL SPME Arrow covers a wide range of applications. However, for dynamic headspace applications, especially for volatiles we recommend ITEX Dynamic Headspace (DHS). This powerful technology achieves ng/L sensitivities without the pitfalls of purge & trap systems.

More Volume: Up to 10x more Sensitivity

The table below shows the dimension of a PAL SPME Arrow 1.5 mm (a), 1.1 mm (b) and a SPME Fiber (c) in comparison:

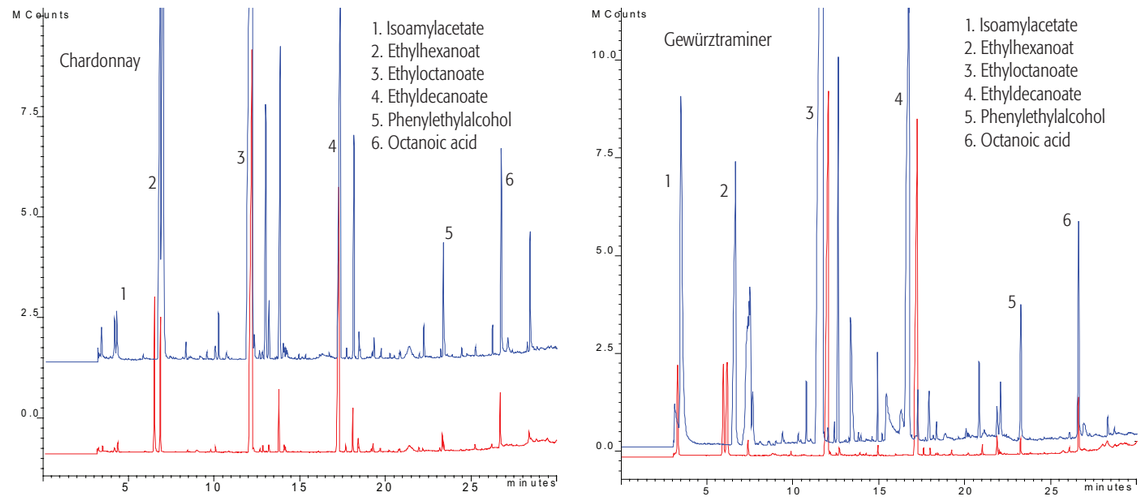
		Sorption phase surface	Sorption phase volume
a		62.8 mm²	11.8 µL
b		44.0 mm²	3.8 µL
c		9.4 mm²	0.6 µL

Immersion Extraction: Polyaromatic Hydrocarbons (PAHs) in Water



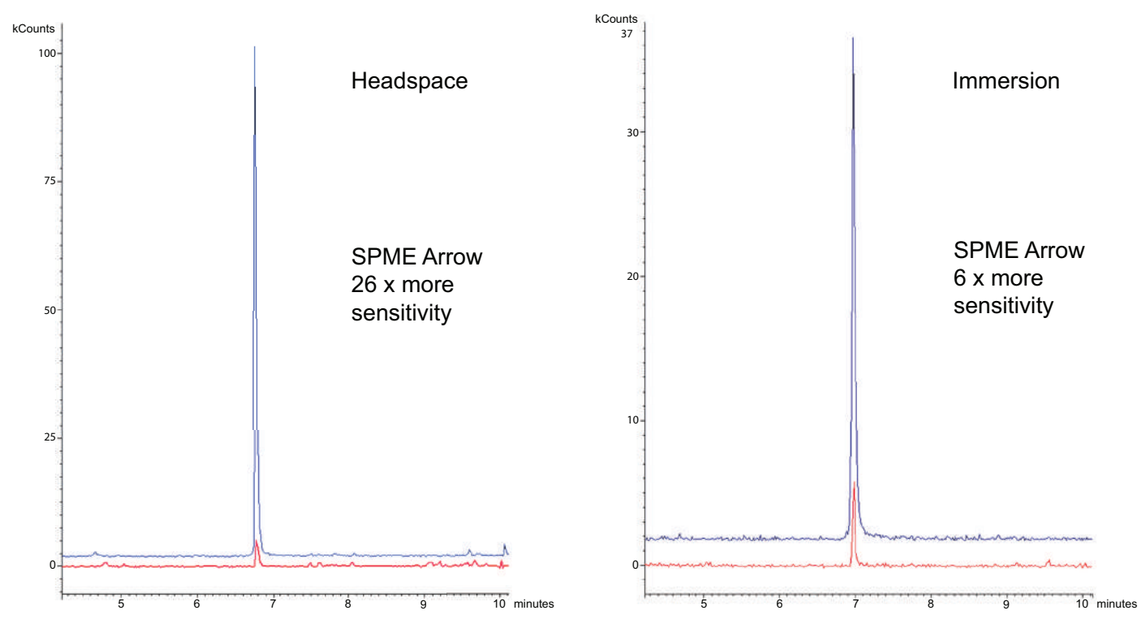
Extraction yields for water samples containing PAHs @ 50 ng/L after 70 min. A PAL SPME Arrow 20 mm x 250 µm Carbon WR was compared to SPME fiber 10 mm x 100 µm Carbon WR immersion (Kremser et al., 2015).

Headspace Extraction: Aroma Analysis in White Wines



Chromatograms showing the headspace extraction of aroma components from different white wines with PDMS fibers (PAL SPME Arrow 100 µm, 20 x 1.1 mm compared to SPME 100 µm, 10 x 0.3 mm)

Iodoform in Water



Extraction of 1 µg/L iodoform from tap water with DVB fibers (headspace and immersion extraction), PAL SPME Arrow 100 µm, 20 x 1.1 mm compared to SPME 100 µm, 10 x 0.3 mm.

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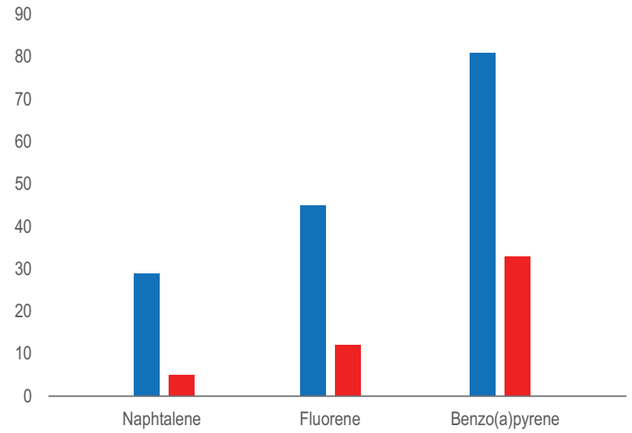
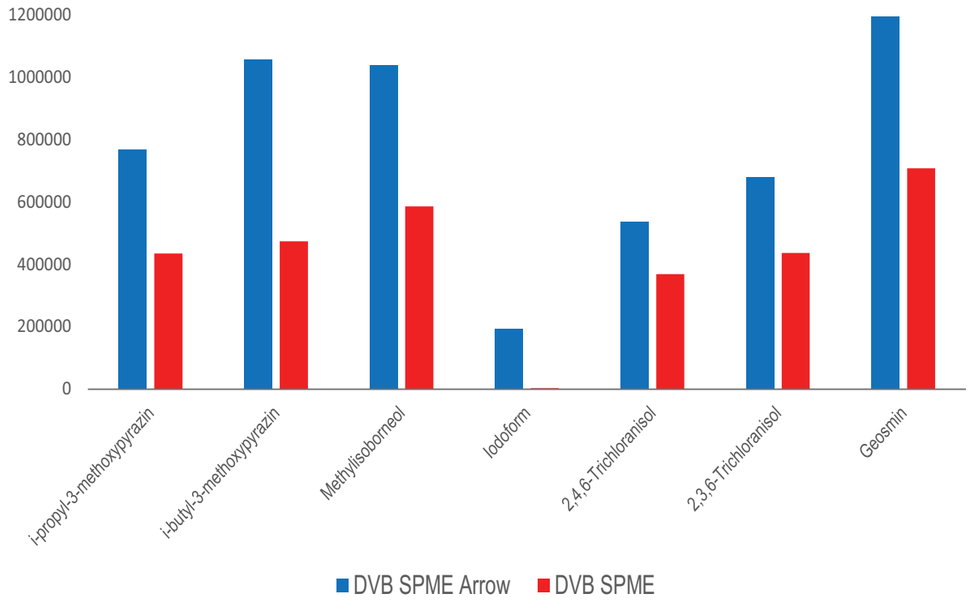
Bigger Surface: 2x Throughput

Immersion Extraction: Polyaromatic Hydrocarbons (PAHs) in Water



Relative immersion extraction yield (measured as % extracted after a 70 min) for PAHs at 50 ng/L with PDMS fibers (PAL SPME Arrow 100 µm, 20 x 1.1 mm compared to SPME 100 µm, 10 x 0.3 mm)

Headspace Extraction: Off Flavor Compounds in Water



Relative headspace extraction yield (measured as amount extracted after 30 min) for off-flavor compounds in water at 100 ng/L with DVB fibers. (PAL SPME Arrow 100 µm, 20 x 1.1 mm compared to SPME 100 µm, 10 x 0.3 mm)

References

[1] Belardi R., Pawliszyn J., Water Pollut. Res.J.Can. 1989, 24, 179

[2] SPME Arrow - Evaluation of a Novel Solid-Phase Microextraction Device for Freely Dissolved PAHs in Water; Kremser A. et al., Anal. Bioanal. Chem. 2016, 408, 943-952

[3] Solid phase microextraction Arrow for the sampling of volatile amines in wastewater and atmosphere; Helin A. Et al., J. Chrom. A 2015, in press

[4] PAL System Application Notes: Determination of iodoform in drinking water by SPME and GC/MS and Determination of C2-C12 aldehydes by SPME on-fiber derivatization and GCMS

With the PAL RTC and RSI the entire SPME process is fully automated. This guarantees process safety and high reproducibility.

PAL Heatex Stirrer - New Mixing and Heating Technology for Sample Preparation and SPME.

The powerful PAL Heatex Stirrer mixes samples rapidly applying cycloid shaped mixing patterns without the need for stir bars. For SPME headspace and immersion sampling the special design (pat. pending) ensures optimal performance.

The PAL Heatex Stirrer offers:

- Rapid equilibration through effective stirring for headspace and immersion SPME sampling while ensuring the integrity of the fiber
- Efficient dissolution of solids, temperature controlled
- Thorough liquid/liquid extraction
- Stirring/heating for derivatization reactions
- No stir bar required, constant stirring also with samples containi
- No cross contamination
- Precise control of the equilibration temperature 40-150 °C
- Software controlled, temperature and stirring speed are logged

PAL SPME Arrow Ordering Information

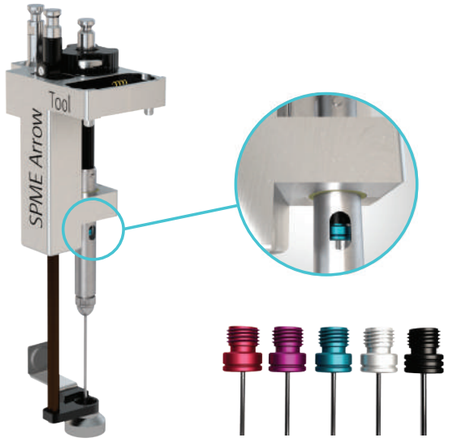
System requirements

- PAL RTC or RSI with firmware 2.3 or higher
- PAL SPME Arrow Tool
- PAL Heatex Stirrer Module
- Adaptation of GC-injector (see page 11)
- A PAL SPME Arrow Conditioning Module is highly recommended, the PAL SPME Fiber Conditioning Module cannot be used with SPME Arrow.
- For overlapped extraction, the Agitator Module is required

The PAL SPME Arrows are available in order quantities of one, three or five SPME Arrows per box.
For method development, a set of each fiber type (set of five) is available.

Diameter	Phase Thickness	Color Code	Set of 1 SPME Arrow Description PNo.	Set of 3 SPME Arrows Description PNo.	Set of 5 SPME Arrows Description PNo.
PDMS SPME Arrow (Polydimethylsiloxane)					
1.1 mm	100 µm	Red	ARR11-P-100/20-P1	ARR11-P-100/20-P3	ARR11-P-100/20-P5
Acrylate SPME Arrow (Polyacrylate)					
1.1 mm	100 µm	Grey	ARR11-A-100/20-P1	ARR11-A-100/20-P3	ARR11-A-100/20-P5
Carbon WR SPME Arrow / PDMS (Carbon Wide Range / PDMS)					
1.1 mm	120 µm	Light Blue	ARR11-C-WR-120/20-P1	ARR11-C-WR-120/20-P3	ARR11-C-WR-120/20-P5
DVB SPME Arrow / PDMS (Divinylbenzene / PDMS)					
1.1 mm	120 µm	Violet	ARR11-DVB-120/20-P1	ARR11-DVB-120/20-P3	ARR11-DVB-120/20-P5
PDMS SPME Arrow (Polydimethylsiloxane)					
1.5 mm	250 µm	Black	ARR15-P-250/20-P1	ARR15-P-250/20-P3	ARR15-P-250/20-P5
SPME Arrow Collection – Development Kit					
One of each type of SPME Arrows above | set of five					ARR1115-SEL5-S1

(Detailed user information can be found in the SPME Arrow Instruction Leaflet.)



Ordering information for required parts

SPME Arrow Starter Kit (injector specific) PNo.: see below		Starter Kit containing – SPME Arrow Tool – SPME Arrow Holder – SPME Arrow Selection of five different SPME Arrows – SPME Arrow Instruction Leaflet – Adapter Kit for GC injector (details see below)
Heatex Stirrer Module PNo.: PAL3-HeatexStirrer		For mixing and heating in sample prep and SPME – Temperature range 30 - 150°C – Mixing speed up to 1600 rpm (200 cycloidal loops) – Optimized for 20 mL vials (for 10 mL vials a special adapter is required)

Ordering information for optional modules

SPME Arrow Conditioning Module PNo.: PAL3-SPME-ArrowCond		For the conditioning of SPME Arrow as well as SPME fibers prior to sample enrichment – Position for automated conditioning – Position for manual pre-conditioning – Automated purge gas valve – Manual gas valve for pre-conditioning – Replacement liners for easy maintenance
Agitator Module PNo.: PAL3-Agitator		The Agitator Module provides 6 positions for 20 mL vials for incubation and agitation of samples. – Temperature range 40 – 200 °C – Agitation speed 250 – 750 rpm – Optional adapters for 2 mL or 10 mL vials

Ordering information for starter kits and suitable liners

Starter Kits	PAL3-ARR-Start-GC2010	Starter Kit SPME Arrow for Shimadzu GC 2010 consisting of: 1 Adaption Kit for the split/splitless injector of Shimadzu GC 2010 (ARR-SSL-Inj-GC2010), 1 Liner Nut, 1 Screw Cap, 2 SPME Arrow Liner,1 SPME Arrow Tool Kit (PAL3-SPME-Arrow-Kit)
	PAL3-ARR-Start-GC6890	Starter Kit SPME Arrow for Agilent GC6890 consisting of: 1 Adaption Kit for the split/splitless injector of Agilent GC 6890 (ARR-SSL-Inj-GC6890), 2 SPME Arrow Liners for SSL Injector of the Agilent GC 6890, 1 SPME Arrow Tool Kit (PAL3-SPME-Arrow-Kit)
	PAL3-ARR-Start-GC7890	Starter Kit SPME Arrow for Agilent GC 7890 consisting of: 1 Adaption Kit for the split/splitless injector of Agilent GC 7890 (ARR-SSL-Inj-GC7890), 2 SPME Arrow Liners for SSL Injector of the Agilent GC 7890, 1 SPME Arrow Tool Kit (PAL3-SPME-Arrow-Kit)
	PAL3-ARR-Start-Tr1300	Starter Kit SPME Arrow for Thermo GC Trace 1300/1310 consisting of: 1 Adaptation Kit for the split/splitless injector of Thermo GC Trace1300/1310 (ARR-SSL-Inj-Trace1300), 2 SPME Arrow Liners for SSL Injector of Thermo GC Trace1300/1310, 1 SPME Arrow Tool Kit (PAL3-SPME-Arrow-Kit)
	PAL3-ARR-Start-TrUltra	Starter Kit SPME Arrow for Thermo GC Trace Ultra consisting of: 1 Adaptation Kit for the split/splitless injector of Thermo GC TraceUltra (ARR-SSL-Inj-TraceUltra), 2 SPME Arrow Liners for SSL Injector of Thermo GC TraceUltra, 1 SPME Arrow Tool Kit (PAL3-SPME-Arrow-Kit)
Suitable Liners	ARR-Liner-CondModule	Liner for SPME Arrow Conditioning Module, package containing 3 pcs
	ARR-Liner-GC2010	SPME Arrow Liner for SSL Injector of SHIMADZU GC 2010, package containing 3 pcs
	ARR-Liner-GC6890	SPME Arrow Liner for SSL Injector of AGILENT GC 6890, package containing 3 pcs
	ARR-Liner-GC7890	SPME Arrow Liner for SSL Injector of AGILENT GC 7890, package containing 3 pcs
	ARR-Liner-Trace1300	SPME Arrow Liner for SSL Injector of Thermo GC Trace1300, package containing 3 pcs
	ARR-Liner-TraceUltra	SPME Arrow Liner for SSL Injector of Thermo GC TraceUltra, package containing 3 pcs

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For more information on the PAL System visit:

www.palsystem.com

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