

User Guidelines für PAL Smart SPME Arrows

- Set the PAL Gas Input pressure to 2bar when using Conditioning Module(s). This enables to reach a conditioning gas flow above 15mL/min.
- Do not extend conditioning times longer than necessary.
- The lifetime of SPME Arrow phase will decrease if exposed to maximum temperature for longer periods.
- Operating Temperatures include Conditioning and Desorption Temperatures in the Injector.
- Conditioning times can be applied for Pre- and Post-Conditioning.
- For liquid immersion extractions, a liquid wash step may help to reduce carryover.
- Injectors may have a temperature gradient that can differ from the actual temperature. Therefore, the optimal Injection Depth may vary depending on the Injector Type.
- Thermal stress shortens the lifetime of the SPME Arrow polymers. Depending on your application, choose the lowest necessary temperature, not the highest possible.
- Prevent permanent storage at conditioning temperatures.
- Injector penetration depth is recommended to set close to maximum possible depth of the GC Injector.
- Injector septa change is recommended after 100 Injections (1.5 mm Arrow), or after 300 Injections (1.1 mm Arrow).
- Early leakage of septa may occur if injector nuts are not tight enough or overtightened.
- SPME Arrow is specified to use at a maximum injector pressure of 50 psi.

No.	Outer Diameter	Phase Thickness	Color Code	Set of 1 Smart SPME Arrow Description PNo.	Set of 3 Smart SPME Arrow Description PNo.	Set of 5 Smart SPME Arrow Description PNo.
PDMS Smart SPME Arrow (Polydimethylsiloxane)						
1	1.1 mm	100 µm	Red	SARR11-P-100/20-P1	SARR11-P-100/20-P3	SARR11-P-100/20-P5
2*	1.5 mm	100 µm	Red	SARR15-P-100/20-P1	SARR15-P-100/20-P3	SARR15-P-100/20-P5
Polyacrylate Smart SPME Arrow						
3	1.1 mm	100 µm	Gray	SARR11-A-100/20-P1	SARR11-A-100/20-P3	SARR11-A-100/20-P5
Carbon WR / PDMS Smart SPME Arrow (Carbon Wide Range / Polydimethylsiloxane)						
4	1.1 mm	120 µm	Light Blue	SARR11-C-WR-120/20-P1	SARR11-C-WR-120/20-P3	SARR11-C-WR-120/20-P5
5*	1.5 mm	120 µm	Light Blue	SARR15-C-WR-120/20-P1	SARR15-C-WR-120/20-P3	SARR15-C-WR-120/20-P5
DVB / PDMS Smart SPME Arrow (Divinylbenzene / Polydimethylsiloxane)						
6	1.1 mm	120 µm	Violet	SARR11-DVB-120/20-P1	SARR11-DVB-120/20-P3	SARR11-DVB-120/20-P5
7*	1.5 mm	120 µm	Violet	SARR15-DVB-120/20-P1	SARR15-DVB-120/20-P3	SARR15-DVB-120/20-P5
DVB / Carbon WR / PDMS Smart SPME Arrow (Divinylbenzene / Polydimethylsiloxane / Carbon Wide Range)						
8	1.1 mm	120 µm	Dark Gray	SARR11-DVB/CWR120/20-P1	SARR11-DVB/CWR120/20-P3	SARR11-DVB/CWR120/20-P5
9*	1.5 mm	120 µm	Dark Gray	SARR15-DVB/CWR120/20-P1	SARR15-DVB/CWR120/20-P3	SARR15-DVB/CWR120/20-P5
Smart Smart SPME Arrow Selection for method development (set of 5 different Smart Smart SPME Arrow types)				Smart SPME Arrow Selection of 5 Smart SPME Arrow standard types No. 1, 3, 4, 6 and 8		
						SARR1115-SEL5-S2

* Smart SPME Arrow wide types - for use with solvents or reagents, that may lead to moderate swelling of PDMS phases.

Table 1. PAL Smart SPME Arrow Order Information.

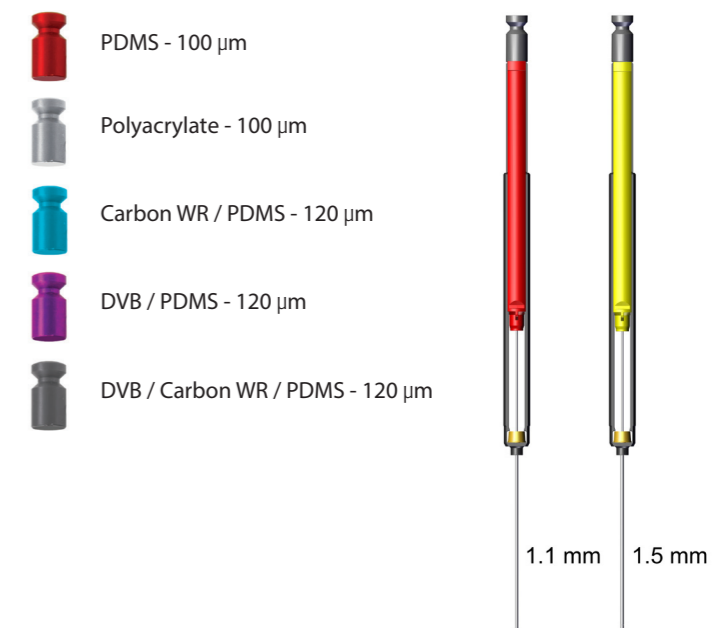
All Smart SPME Arrows have a phase length of 20 mm. Smart SPME Arrow cannot be used with standard SSL injectors of most GC manufactures. The use of the specific Smart SPME Arrow Adaptation Kit is mandatory. Liners in the injector must be selected to fit Smart SPME Arrows with 1.1 mm or 1.5 mm diameter. Please see the list of available kits at the end of this document. The Smart SPME Arrow assortment and the range of applications will be constantly expanded and developed.

General Information for PAL Smart SPME Arrow

Note:

This data sheet contains important notes for the operator. It is highly recommended for operators to become familiarized with the product prior to use.

- PAL3 Firmware 3.1 or higher is required for the use of Smart SPME Arrows with the complete scope of functions.
- The use of the SPME Arrow Conditioning Module and the Heatex Stirrer together with the Smart SPME Arrows is essential.
- The SPME Fiber Conditioning Module cannot be used with Smart SPME Arrows.
- Depending on the brand of the used Gaschromatograph (GC), it might be mandatory to adapt the inlet of the GC prior to the use of SPME Arrows. Please contact your GC provider for more details. Adaptation kits are available for the following types of GCs: TMO Trace Ultra / 1300 / 1310, Agilent GC 6890 / 7890, and Shimadzu GC 2010.
- To facilitate the differentiation between the two different thicknesses of the Smart SPME Arrows, and to help avoiding any mistake, each Smart SPME Arrow comes either with a yellow (1.5 mm thickness) or with a red (1.1 mm thickness) plastic part.
- The color code, as provided in table 1 reflects the type of the coating in combination with its thickness.



No.	Stationary Phase Arrow Type	Maximum Temperature (°C)	Recommended Operating Temperature (°C)	Conditioning Time (min.) Min Max Recom.	Arrow Rinsing Solvent	Arrow Rinsing Time (min.) Min Max Recom.
PDMS Smart SPME Arrow						
1 & 2	100 µm	300	200 - 280	1 30 5	MeOH EtOH iProp	0.5 10 2
Polyacrylate Smart SPME Arrow						
3	100 µm	280	200 - 250	1 30 5	MeOH EtOH aliphatic HC	0.5 10 2
Carbon WR / PDMS Smart SPME Arrow						
4 & 5	120 µm	300	200 - 300	1 30 5	MeOH	0.5 10 2
DVB / PDMS Smart SPME Arrow						
6 & 7	120 µm	300	220 - 270	1 30 10	MeOH EtOH iProp	0.5 10 2
DVB / Carbon WR / PDMS Smart SPME Arrow						
8 & 9	120 µm	300	220 - 270	1 30 10	MeOH EtOH iProp	0.5 10 2
MeOH = Methanol		EtOH = Ethanol		iProp = Iso-Propanol (2-Propanol)		aliphatic HC = aliphatic hydrocarbons (e.g. n-Hexane)

Table 2. Operational Parameters for PAL Smart SPME Arrows.

PAL System certified Vials and Caps are recommended for SPME Applications:

Vial-20-DC20-CG-100	PAL System Vial 20CV, 20 mL clear glass for headspace. 75.5 x 22.5 mm, 1st class hydrolytic glass, DIN-crimp neck, Pk of 1000 pcs
Cap-DC20-St-SP15-100	PAL System Crimp Cap for Headspace, SPME Fiber and SPME Arrow. 20 mm with 8 mm center hole, silicone / PTFE septa 3.0 mm with thinned center 1.5 mm. Pk of 100 pcs

PAL Smart SPME Arrow Conditioning, Cleaning and Handling

Caution:

Without gas protection the Smart SPME Arrow surface will be damaged, if exposed to elevated temperatures.

Smart SPME Arrow Preconditioning

Prior to analytical use, it is mandatory to precondition each Smart SPME Arrow at a specified temperature in an inert gas phase environment. The life span of the Smart SPME Arrow can be extended if it is not unnecessarily preconditioned at maximum temperature.

Generally, it is recommended to precondition the Smart SPME Arrow 20°C above the planned operating temperature, while respecting the maximum temperature threshold. Recommended temperatures and conditioning times are given in Table 2.

Smart SPME Arrow Conditioning

It is part of the analytical process to condition the Smart SPME Arrow after thermal desorption of the analytes has been completed. This conditioning is a preparatory step for the next analytical run.

It is necessary to eliminate all possible contaminants from the Smart SPME Arrow which have not been desorbed and transferred to the GC column.

To avoid contamination of the GC inlet system and/or the GC column, it is recommended to remove the Smart SPME Arrow after the thermal desorption step from the GC injector and move the Smart SPME Arrow Tool to the SPME Conditioning Module for the conditioning step.

The large surface of the Smart SPME Arrow can trap impurities from the ambient atmosphere if a Smart SPME Arrow has been left in the open. Considering this, it is good recommended practice to run a blank prior to running a series of analytical samples. Evaluating the baseline level of the GC detector helps to ensure that the entire system, such as the Smart SPME Arrow, the GC inlet, the GC column, and detector, is free from any contaminants.

Rinsing of Smart SPME Arrows

It is possible to clean the Smart SPME Arrow using an organic solvent, should the Smart SPME Arrow be subject to inappropriate storage, e.g. keeping it in the open at ambient environment without protection for a prolonged period, or if obvious dust particles are sticking to the Smart SPME Arrow. The recommended types of solvents are listed in Table 2.

Do not use any other solvents than those mentioned here. Other solvents can cause a swelling of the Smart SPME Arrow which would lead to significant damage. It is important that a Smart SPME Arrow is not cleaned mechanically by any means; do not touch the Smart SPME Arrow with fingers, not even when wearing gloves. The cleaning process can be done manually by dipping the Smart SPME Arrow into a container filled with the appropriate solvent or in an automated manner by defining a vial for cleaning.

To avoid a potential misunderstanding, do not use a wash or waste solvent of the Wash Module from the PAL System. This solvent can be contaminated or the solvent in use may not be suitable for the particular Smart SPME Arrow type.

General Remarks for Smart SPME Arrow Conditioning

Table 2 summarizes the various parameters for conditioning and cleaning. The values provided are empirical values which are suitable for a number of applications and give reliable results.

Typical Lifetime

The life span of a Smart SPME Arrow depends to a great degree on the field and type of application. Using the SPME technique, by inserting the Smart SPME Arrow into a liquid with a high degree of matrix, the number of analyses can vary from a few to approximately 100 analyses. If the Smart SPME Arrow is positioned in the headspace of a vial and avoids any contact with liquid and matrix, it is typically possible to run several hundred extractions. The table below gives an average value for each of the two possible uses of the Smart SPME Arrows, in order to be able to estimate the lifetime.

Technique	Immersion	Headspace
Number of analyses	100	500

Lifetime of SPME Arrow is depending on method conditions. In general, the lifetime is decreased by thermal stress during conditioning and desorption. Headspace applications generally refer to lower Temperatures and significant longer lifetime than Immersion applications.

Typical counts for Immersion extractions are 200 cycles @ <250°C; 100 cycles @ <270°C; 20 cycles at max. Temperatures. (Max. Temperatures see Table 2 above).

Lifetime of SPME Arrows is also depending on sufficient Gas Flow during desorption and conditioning (i.e. 20mL/min). For liquid immersion, any particles in the liquid phase should be avoided. In case of particle loaded liquids a filtration or centrifugation prior to extraction can increase the lifetime.

It is not possible to visually judge the Smart SPME Arrow quality if there are no obvious signs of major mechanical damage, such as a fracture.

Any sign of staining, caused by a starting vitrification of the surface in case of a PDMS Smart SPME Arrow, or signs of a yellowish discoloration in the case of a Polyacrylate Smart SPME Arrow, does not give any indication on the remaining life span of the particular Smart SPME Arrow.

As a rule of thumb, the life span of a Smart SPME Arrow can be extended if its exposure to high temperatures is minimized. Do not exceed the maximum temperature for each Smart SPME Arrow type as shown in Table 2.

Headspace Extraction: Sample Volume and Penetration Depth

For Headspace Extractions in PALsystem 20mL vials:

Sample Volume [mL]	Penetration Depth [mm]
< 10	30
> 10 not recommended	-

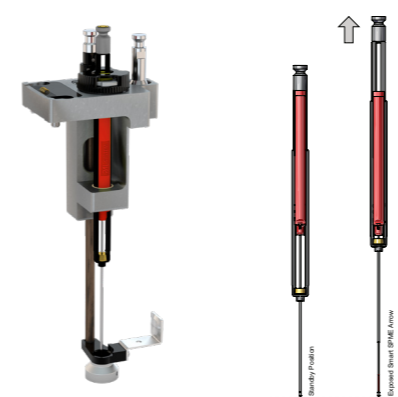
Liquid Immersion: Sample Volume and Penetration Depth

For Liquid Immersion Methods, we recommend to use 20mL Vials with following Liquid Sample Volumes and respective penetration depth. These settings will give best extraction conditions with minimized moisture transfer for liquid immersion.

Sample Volume [mL]	Penetration Depth [mm]
< 15 not recommended	-
15	50
16	45
17	40
18	30
> 18 not recommended	-

Prerequisites Mandatory Tool and Modules for the use of Smart SPME Arrows

The PAL Smart SPME Arrows are compatible with the following Tool and Modules:



SPME Arrow Tool

The SPME Arrow Tool and the Smart SPME Arrow collection are part of the PAL3 SPME Arrow kit. It can be used with the PAL3 System models PAL RTC and PAL RSI or with the corresponding products and models distributed under different names by OEM partners. For the PAL3 System, the Smart SPME Arrows allow a maximum needle penetration depth of 70 mm.

Note: This tool cannot be used with SPME Fibers and is not compatible with previous PAL and PAL-xt Systems.

Heatex Stirrer

A Heatex Stirrer is mandatory to incubate, equilibrate, and extract samples either from headspace or liquid phase (immersion).

SPME Arrow Conditioning Module

The SPME Arrow Conditioning Module offers the functionality to clean (bake-out) the inserted Smart SPME Arrow in an inert gas phase after the analytical process to prepare it for the next analysis. This module is strongly recommended since it will help to protect the GC injection port from contamination and free up the port after thermal desorption.

SPME Arrow Adaption Kits for GC

ARR-SSL-Inj-TraceUltra	SPME Arrow adaption kit for split/splitless injector of Thermo GC Trace Ultra
ARR-SSL-Inj-Trace1300	SPME Arrow adaption kit for split/splitless injector of Thermo GC Trace 1300 / 1310
ARR-SSL-Inj-GC6890	SPME Arrow adaption kit for split/splitless injector of Agilent GC 6890
ARR-SSL-Inj-GC7890	SPME Arrow adaption kit for split/splitless injector of Agilent GC 7890
ARR-SSL-Inj-GC2010	SPME Arrow adaption kit for split/splitless injector of Shimadzu GC 2010



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