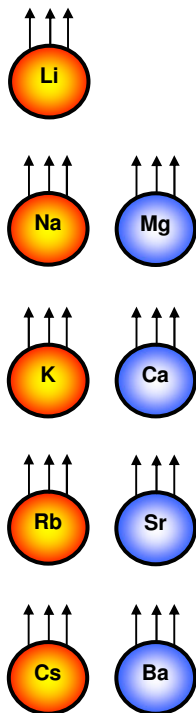




Chromate-free metal vapor sources for Li, Na, K, K40, Rb, Cs, Ca, Sr, Ba, Yb



ALVASOURCES[®] for

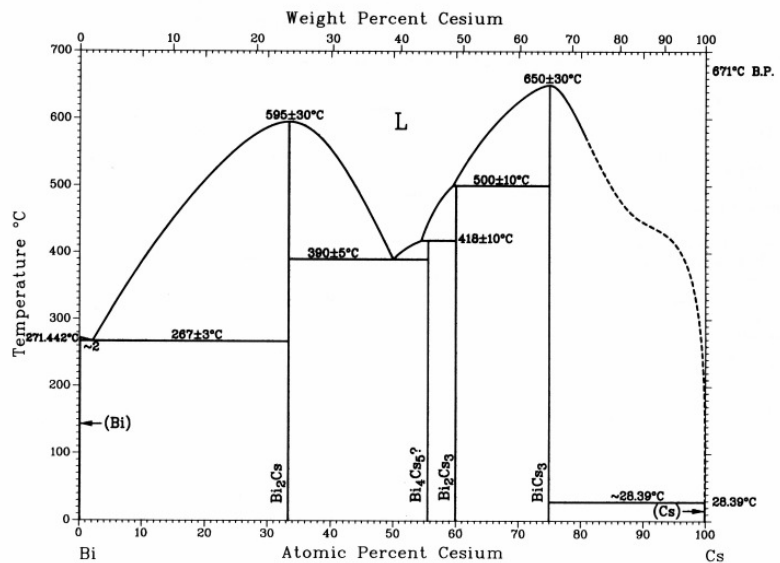
- ◇ BOSE EINSTEIN CONDENSATION
- ◇ MAGNETO-OPTICAL-TRAPS
- ◇ FUNDAMENTAL RESEARCH
- ◇ PHOTOMULTIPLIERS
- ◇ IMAGE INTENSIFIER TUBES
- ◇ OLEDs

high-tech metallurgy - chemically active materials

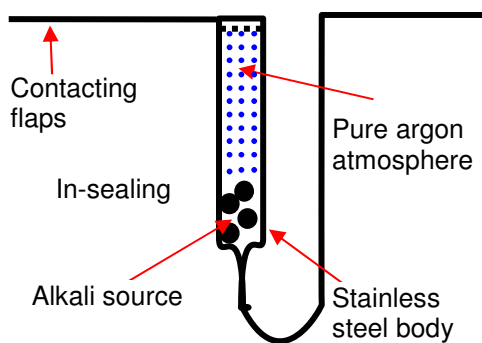
1. Technology

Alkali and alkali earth metals form many stable, high melting intermetallic compounds with non-toxic metals, like indium, gallium, tin or bismuth (see Fig1). The relatively low boiling point or sublimation point of alkali metals makes pure alkali metals inappropriate for use in high vacuum evaporators which are usually baked out at temperatures between 200°C (392°F) and 400°C (752°F) for many hours. This very low sublimation temperature can be significantly increased by high melting intermetallic alkali compounds with a high enthalpy of formation like Bi_2Cs ($T_M=595^\circ\text{C}$, 1103°F) or BiCs_3 ($T_M=650^\circ\text{C}$, 1202°F). The sublimation temperature of the intermetallic compound Bi_2Cs at $1\text{E}-6$ mbar is ca. 450°C (842°F), which is about 430°C (770°F) more than the sublimation temperature of pure Cs which is 22°C (72°F) at $1\text{E}-6$ mbar.

Bi-Cs Phase Diagram



Binary equilibrium phase diagram of CsBi



Principle of ALVASOURCE®

The desired alloy containing the alkali or alkali earth metal is specially produced under ultra high vacuum conditions. A small stainless steel tube which is gas-tight sealed by a pressed indium sealing is filled with the alloy under pure argon atmosphere (see Fig. 2). When used, the source is heated via conventional resistance heating. As a consequence, the indium sealing melts and the small argon puffer is instantly pumped away during the standard industrial bakeout procedure. The Alvasource releases ultra-pure alkali metal when the activation current is reached. There is only one physical natural limit when using Alvasources: the temperature, i.e. the current, must not be increased above the indicated specification limit to prevent sublimation of non-alkali metals in the alloy. Patents granted.

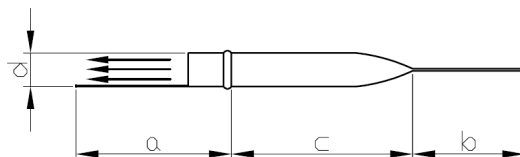
2. Standard Alvasource Types and Capacities

The simple and flexible design of the Alvasources guarantees easy handling and functionality. The contacting flaps can be bent easily to fit into any vacuum evaporator.

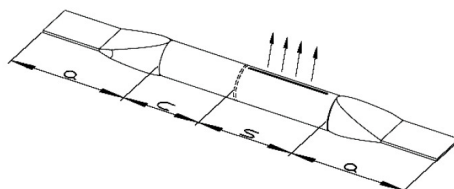
Alvasource Types

Drawings

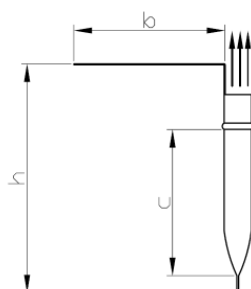
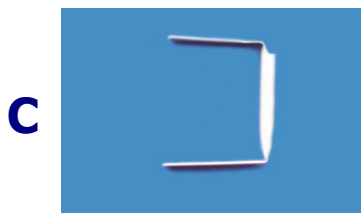
Standard Dimensions



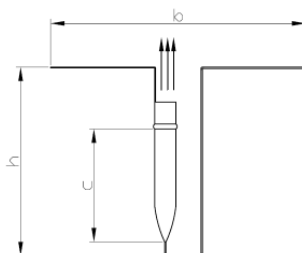
$2\text{mm} < d < 6\text{mm}$
 $a = 35\text{mm}$
 $b = 30\text{mm}$
 $C_{\min} = 15\text{ mm}$
 $l = 65\text{mm} + c$



$2\text{mm} < d < 6\text{mm}$
 $a = 10\text{mm}$
 $s = 5\text{mm}$
 $C_{\min} = 10\text{ mm}$
 $l = 25\text{mm} + c$



$2\text{mm} < d < 6\text{mm}$
 $b = 30\text{mm}$
 $C_{\min} = 15\text{ mm}$
 $h = c + 10\text{mm}$



$2\text{mm} < d < 6\text{mm}$
 $b = 65\text{mm}$
 $C_{\min} = 15\text{ mm}$
 $h = c + 10\text{mm}$

The types F,C and V can be mounted horizontally and vertically, but we do not recommend an upside down evaporation. If this is required please chose the S-type which can be mounted in either directions.

Due to the manufacturing process the total length can slightly vary. All sources can be easily cut by customers to the desired length. The indium sealings must not be damaged before usage.



3. Alvasource Configuration Table

Please configure your own Alvasource. You can alter the parameter diameter and hence the relating length of the metals depot. Most applications can be done with diameters between 2mm and 6mm. For special solutions we can also make sources with higher diameter, e.g. 12mm. For capacities up to 50mg we recommend the 3mm diameter. The length of the metal depot will be then the minimum length c_{min} .

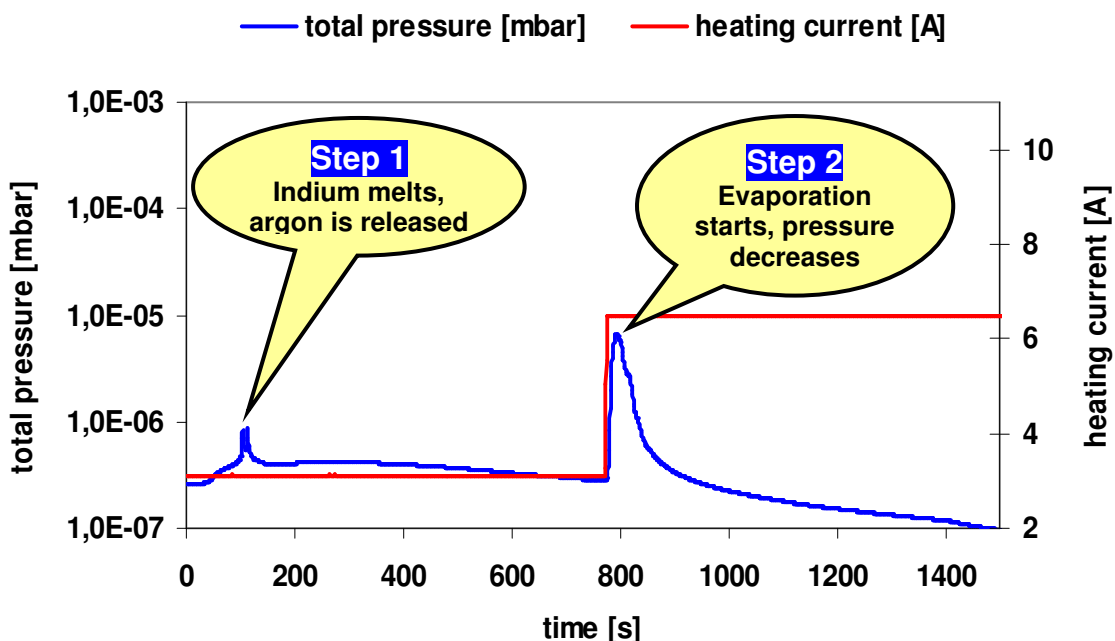
Diameter	d=2mm	d=3mm	d=4mm	d=5mm	d=6mm	d=12mm
Capacity	C [mg/cm]	C [mg/cm]	C [mg/cm]	C [mg/cm]	C [mg/cm]	C [mg/cm]
Li	-	17	30	50	70	280
Na	12	30	50	85	125	500
K, K40	10	25	40	65	95	385
Rb	25	60	100	160	240	965
Cs	40	100	170	280	415	1660
Ca	20	50	85	140	210	830
Sr	20	50	85	140	210	830
Ba	40	100	170	280	415	1660
Yb	70	170	290	470	700	2800

4. Activation and Evaporation

Alvasources® can be mounted under ambient air conditions. The activation process comprises two steps which can be easily monitored by measuring the total pressure:

1. Indium melts at 2A-4,5A depending on design, argon is released (small peak)
2. Alkali metal is released at 4A-17A depending on design, alloy and pressure.

Step 1 can be skipped if the indium sealing melts during a bake-out procedure at $T > 160^{\circ}\text{C}$ for several hours.





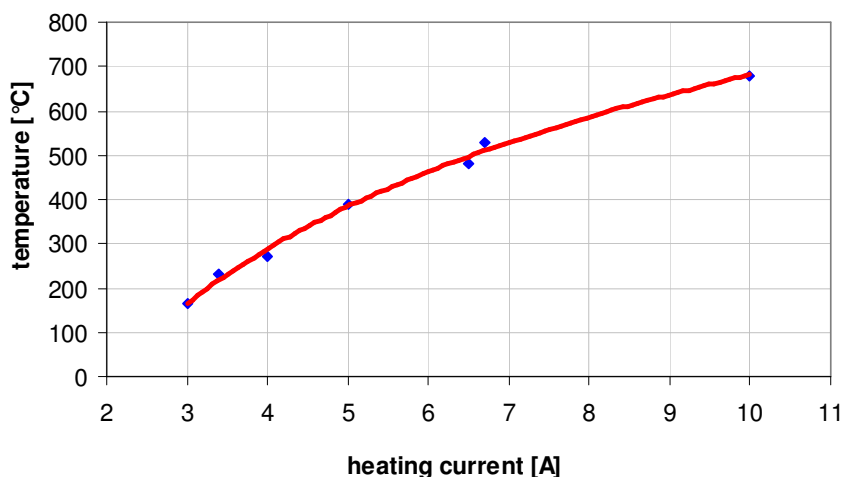
Alvasource Activation Parameters						
AS-Type (F,C,V,S)	2mm > d > 3mm		4mm > d > 6mm		Bake Out	
	Activation	Evaporation	Activation	Evaporation	T _{max,UHV}	T _{max,XHV}
Li	3A 5min	9A-13A	4,5A 5min	11A-14A	450°C	250°C
Na	3A 5min	4,5A-8A	4,5A 5min	6A-10A	380°C	200°C
K, K40	3A 5min	4,5A-8A	4,5A 5min	6A-10A	350°C	200°C
Rb	3A 5min	4A-8A	4,5A 5min	5A-9A	300°C	150°C
Cs	3A 5min	4A-8A	4,5A 5min	5A-9A	300°C	150°C
Mg	3A 5min	7A-13A	4,5A 5min	8A-16A	200°C	200°C
Ca	3A 5min	8A-14A	4,5A 5min	9A-16A	300°C	200°C
Sr	3A 5min	7A-13A	4,5A 5min	8A-16A	400°C	200°C
Ba	3A 5min	8A-14A	4,5A 5min	9A-16A	400°C	200°C
Yb	3A 5min	8A-14A	4,5A 5min	9A-16A	400°C	200°C

Indicated values are only valid for standard **Alvasources**® with c=10mm-30mm. The values can vary for larger sources and different pressure levels.

5. Temperature of Alvasource®

The temperature of the tube can be estimated by the following correlation which is only valid for standard Alvasources with 3mm diameter.

temperature - current correlation of AS 3mm tube



6. Handling

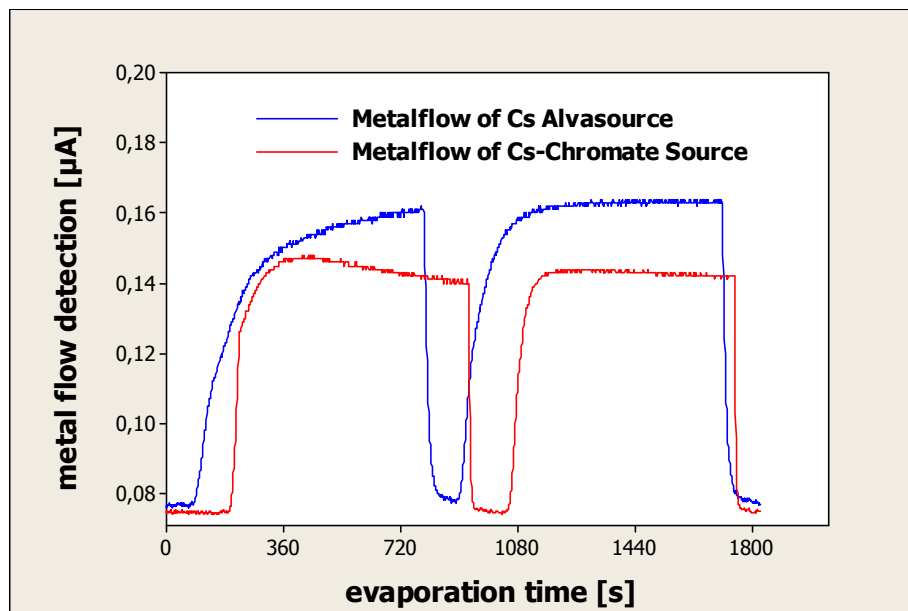
Alvasources® can be safely handled and mounted in ambient air conditions. All of our sources are vacuum baked-out, so we recommend touching them only with latex gloves. Cotton gloves should be avoided. The indium sealing must not be damaged either mechanically or thermally before the usage of the sources.

7. Degassing

Alvasources® need 5 minutes at 2A-4,5A to pump the argon away. They do not need an additional degassing. However, after the indium has been molten the source can withstand a normal industrial bake-out procedure provided that the temperature of the source does not exceed the indicated maximum degassing temperature.

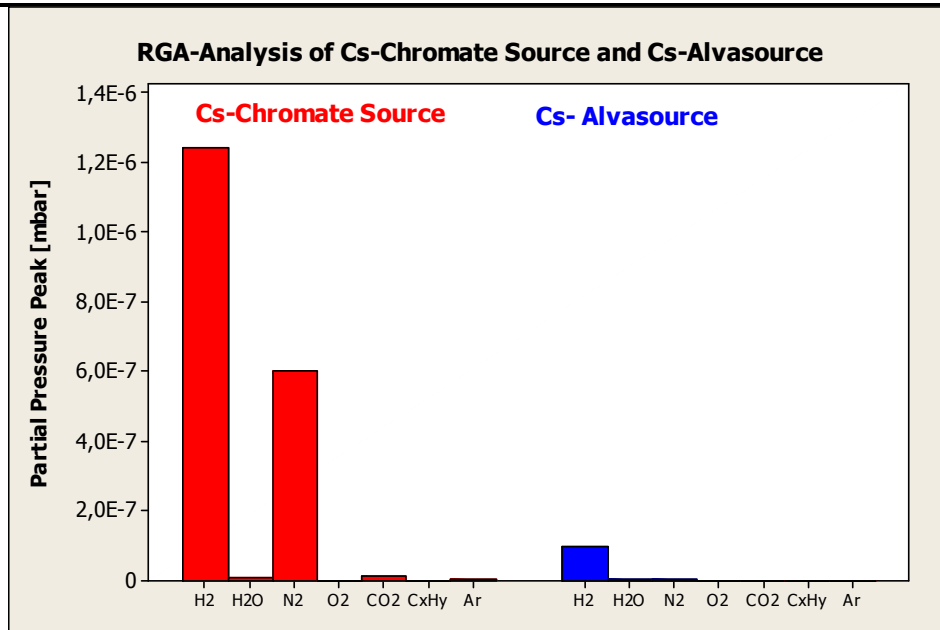
8. Adjustability

After the activation current is reached (in this case 5A) Alvasource releases pure alkali metal vapor. When the heating current is stopped, the flow stops instantly. When the source is turned on again it reaches the same level as before. Compared to alkali chromate sources, Alvasources provide a smoother release of metal which is advantageous for fine tuning of the flow.



9. Purity

During the evaporation process the composition of the residual gas is monitored with a SRS-100 RGA mass spectrometer. Comparison with alkali chromate sources shows that Alvasources release ultra pure alkali vapor. After a bakeout process at 400°C for 14h chromate sources release lots of hydrogen, water and also a little of carbon dioxide. Alvasources do not release relevant interfering gases.



10. Applications

- Bose-Einstein-Condensation
- Magneto Optical Trapping
- Photomultiplier tubes
- Night vision tubes
- X-Ray image intensifier tubes
- OLEDs
- Surface studies

Alvasources® perfectly meet all requirements for Bose-Einstein Condensation (BEC) experiments and Magneto Optical Traps (MOT).

Advantages of Alvasources®

- UHV/XHV compatible
- very pure alkali metal vapor
- no contamination with unwanted gases during operation
- alkali metal vapor is exactly controllable
- Customized designs easily possible
- Customized capacities easily possible
- Quick delivery
- Isotopes, e.g. K40, available
- Chromate-free alkali source, RoHS compliant
- Ultra pure alkali metal release
- No loose particles
- Controllable metal flow
- Flexible design for multiple applications
- Easy to use
- Easy to dispose of

Please contact us for availability and specific enrichment grades.



11. Packaging, Labelling and Storage

Alvasources® are shipped in labelled cans under argon atmosphere. Each source is stamped with the chemical symbol and yield of containing metal in [mg] (e.g. Cs-5, Na-20, K-50, Rb-100). After the first opening of the can we strongly recommend to store the sources in dry and cool atmosphere, preferably under nitrogen or argon. Provided that storage conditions are as described above, the shelf life of our sources can be several years.

12. Coding

AS– diameter[mm]- Metal -capacity [mg]-type

Examples:

AS-3-K-20-C: 3 mm Alvasource with 20mg K, C-shape, h=25mm

AS-4-Rb-100-F: 4mm Alvasource with 100mg Rb, F shape, l=80mm

AS-5-Cs-500-S: 5mm Alvasource with 500mg Cs, S shape, l=45mm

The total length of the sources is a function of capacity and diameter:

13. Environmental Issue

After usage the chromate-free **Alvasources**® can be easily neutralised with great excess of water or citric acid. Barium residuals must be neutralised with sulfuric acid. The resulting barium sulfate is non-toxic and can be disposed of easily. Please consult also local and national regulations for proper disposal of alkali and alkali earth metals as well as for proper disposal of other alloying agents (e.g. Bi, In). Further information is provided in our material safety data sheets (MSDS) which can be also downloaded from our webpage.

14. Contact

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