



**Chromate-free vapor sources for Li, Na, K, Rb, Cs, Ca, Sr, Ba
and other metals made of intermetallic compounds**



**ALVASOURCE[®] for
PHOTOMULTIPLIERS, OLEDs and
BOSE EINSTEIN CONDENSATION**

- **Chromate-free vapor sources**
- **RoHS compliant**
- **Ultra pure alkali metal release**
- **Controllable metal flow**
- **Flexible design**
- **No loose particles**

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 ($T_M=595\text{ °C}$, 1103 °F) or BiCs_3 ($T_M=650\text{ °C}$, 1202 °F). The sublimation temperature of the intermetallic compound Bi_2Cs at 1E-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 1E-6 mbar.

Bi-Cs Phase Diagram

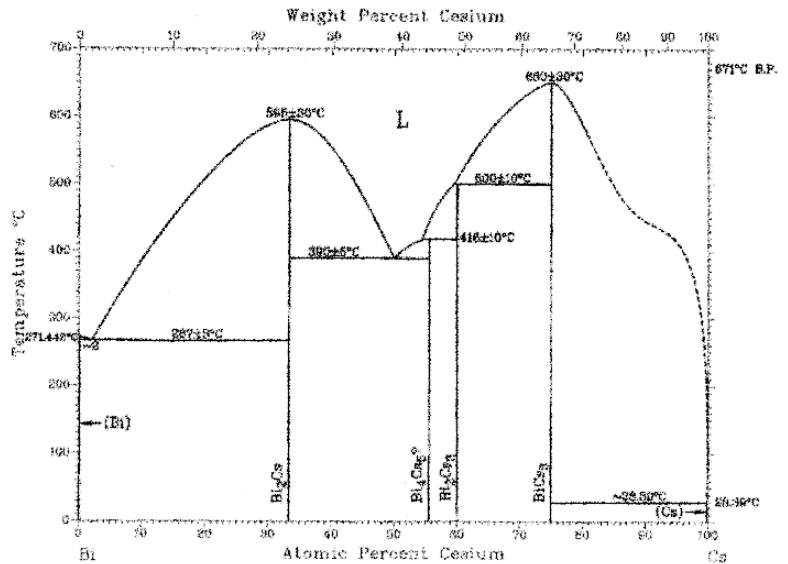


Fig 1: Binary phase diagram of CsBi

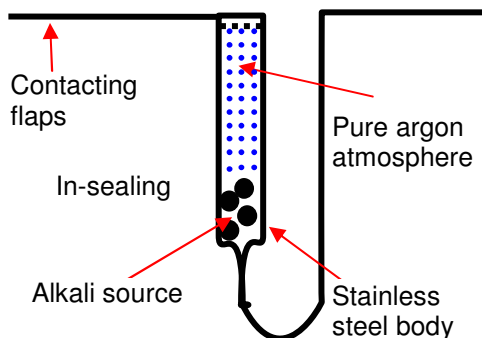


Fig 2: Principle of ALVASOURCE®

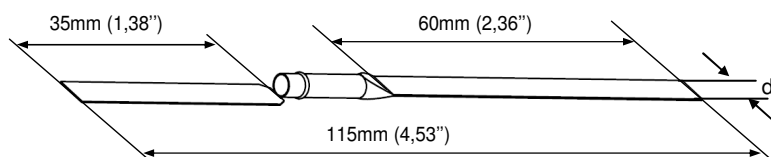
The desired alloy containing the alkali or alkali earth metal is specially produced under ultra high vacuum conditions. A small stainless steel tube which is gas-tight sealed by a pressed indium sealing is filled with the alloy under pure argon atmosphere (see Fig. 2). When used, the source is heated 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 pending.

2. Design

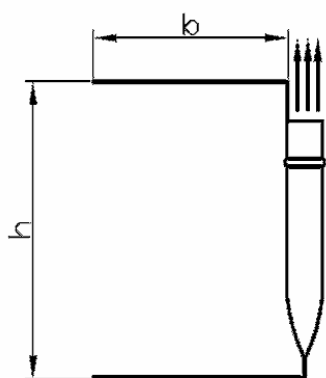
Alvasources' simple design guarantees easy handling and functionality. The contacting flaps can be cut and bent easily to fit into any vacuum evaporator.

Standard Alvasources:

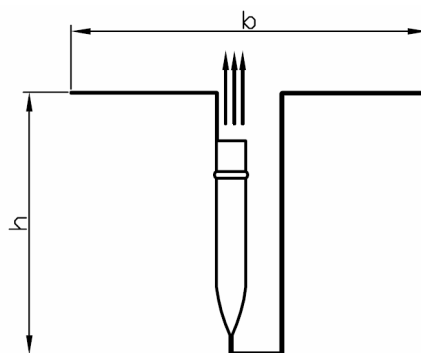
One Design – Multiple Applications



tube material: stainless steel

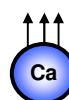
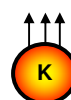


$b_{max} = 30\text{mm (1,18'')}$
 $h = 25\text{mm (0,98'')}$
 $d = 4\text{mm (0,16'')}$



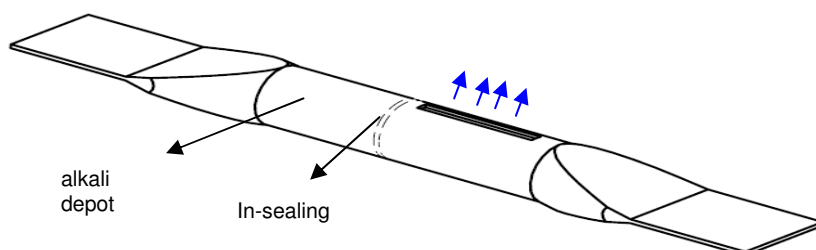
$b_{max} = 65\text{mm (2,55'')}$
 $h = 25\text{mm (0,98'')}$
 $d = 4\text{mm (0,16'')}$

Standard Alvasources



Alvasources with other metals (Te, Se, Sb, K40 etc.) and customized designs are possible.

Alvasource® with slit evaporation (position independent):



Length and diameter of Alvasource® can be adjusted.

Length: $32\text{mm} < l < 500\text{mm}$

Diameter: $1,9\text{mm} < d < 12\text{mm}$

Length and diameter of Alvasource® depends on ordered capacity. Please contact us for further information.

3. 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-4A depending on design, argon is released (small peak)
2. Alkali metal is released at 4A-15A depending on design and alloy.

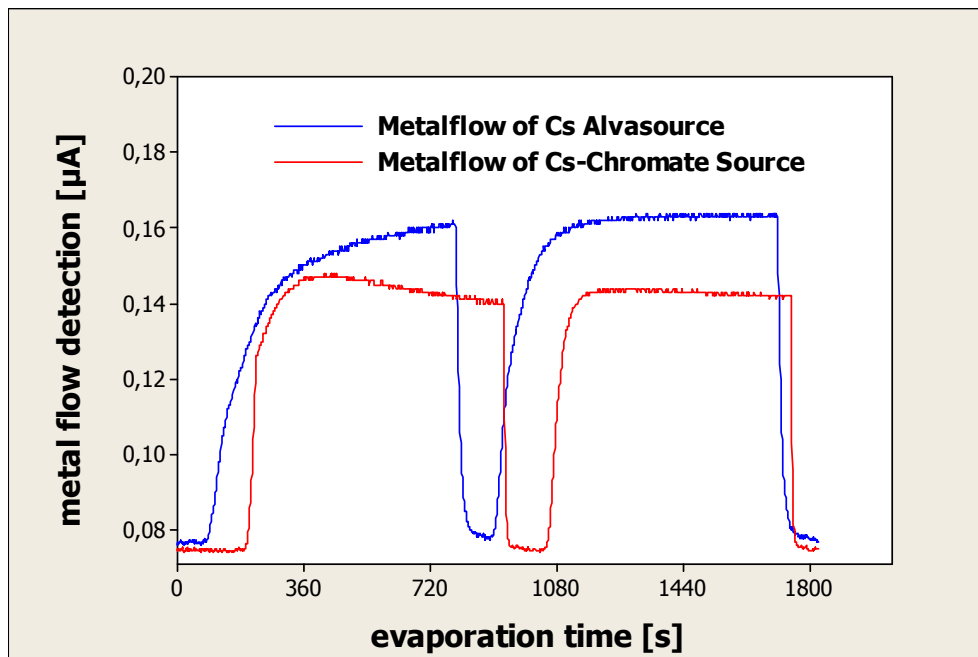
Step 1 can be skipped if the indium sealing melts during a bake-out procedure at $T > 160^\circ\text{C}$ for several hours.

Alvasources			
AS-Type	Step 1	Step 2 ($p < 1\text{E-}6$ mbar)	Maximum degassing temperature
Li	3A 5min	9A-11A	450 °C (842 °F)
Na	3A 5min	4,5A-7,5A	450 °C (842 °F)
K	3A 5min	4,5A-7,5A	450 °C (842 °F)
Rb	3A 5min	4A-7A	450 °C (842 °F)
Cs	3A 5min	4A-8A	450 °C (842 °F)
Ca	3A 5min	8A-12A	500 °C (932 °F)
Ba	3A 5min	12A-15A	500 °C (1202 °F)
Capacity of standard Alvasources [mg]		5 / 10 / 20 / 30 / 50	
Capacity of large Alvasources [mg]		100 / 500 / 1000 / 5000 / 10000	

Indicated values are only valid for standard **Alvasources®** with standard filling. The values can slightly vary for customized designs.

4. Adjustability

During the production of photocathodes it is very important to control the alkali metal flow accurately. It is furthermore desirable that multiple alkali vapor sources can be turned on and turned off in a row, so that various combinations of pure alkali layers can be formed.



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.

5. Bose Einstein Condensation

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

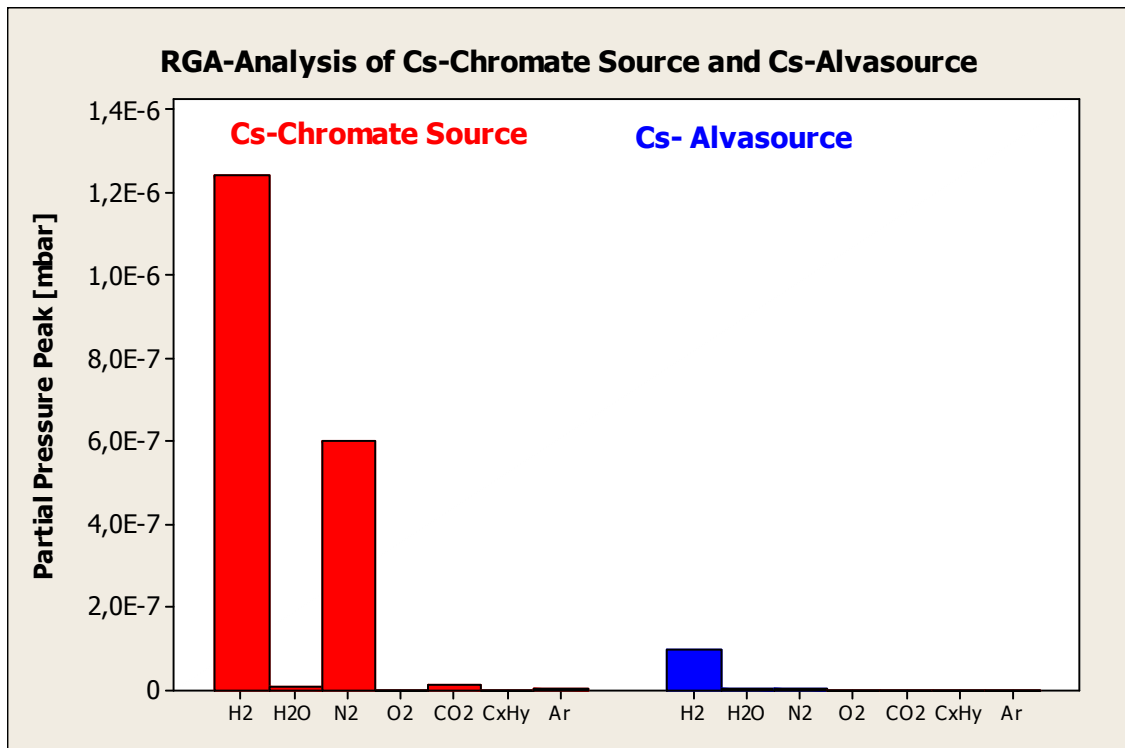
Advantages of Alvasources®

- 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

Please contact us for further information.

6. 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.






7. Coding

Coding of standard Alvasources:

Alvasource-Metal-yield [mg]-shape parameter

Examples: AS-Na-20-C, AS-K-10-V, AS-Rb-50-F, AS-Cs-100-F, AS-Cs-30-S

Shape parameter: F = Flat source 
 C = C-shaped Source 
 V = V-shaped Source 
 S = flat source with evaporation slit

If you order F-shaped sources you can easily transform them into C-shaped or V-shaped sources at your own.



8. 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).

9. Applications

Alvasources' design and capacities meet the demands of the following applications:

- Night vision tubes
- Photomultiplier tubes
- X-Ray image intensifier tubes
- OLEDs
- Bose-Einstein-Condensation
- Laser cooling (MOT)
- Surface studies

10. Product Advantages

- Chromate-free alkali source, RoHS compliant
- Ultra pure alkali metal release
- No loose particles
- High mass portion of alkali metal
- Controllable metal flow
- Can be reactivated reliably → multilayers are possible
- Flexible design for multiple applications
- Can be used as vapor source or evaporable getter
- Easy to use
- Easy to dispose of

11. Contact

For orders and more information please contact:

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