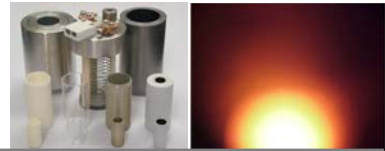




Crucible Selection Guide





Luxel offers two standard crucibles and an expanding line of specialty crucibles. All crucibles are high purity material and have a precision ground lip to provide a vapor seal, which prevents contamination of the radiation baffles. Refractory metal crucible liners are available to ensure compatibility with the widest possible range of source materials.

Crucible Selection

The two primary considerations in selecting a crucible are chemical and thermal compatibility. There are a number of resources available on the web for determining crucible chemical compatibility of most common deposition materials. Thermal compatibility is a concern with materials that melt during evaporation. Molten materials conform to the shape of the crucible. After the deposition when the melt solidifies, differences in thermal expansion rates can cause the crucible to crack. In the case of melting materials, there are three solutions to avoid crucible cracking. Luxel offers metal liners which can withstand the difference in expansion without cracking. If you desire to run the source material without using a metal liner, one solution is to use a limited amount of source material so that the bottom of the crucible is not covered. A second approach which does not require the metal liner is to ensure all material is evaporated from the crucible prior to cooling. Crucibles should not be filled greater than $\frac{3}{4}$ full with non-subliming materials.

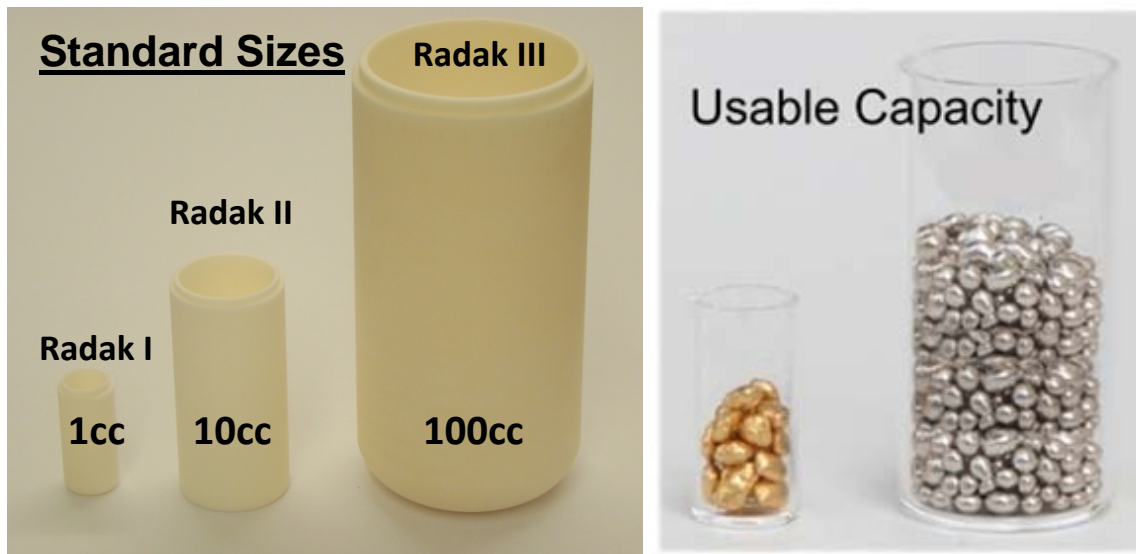
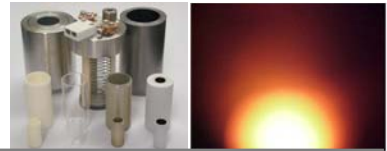


Figure 1 Left: Standard sizes with capacities of 1, 10, and 100cc respectively. Right: Recommended fill level is $\frac{3}{4}$ full.

Standard Crucibles

Our standard crucibles are alumina (above left) or quartz (above right). One crucible is supplied with each Radak furnace purchased. Alumina is the default crucible material with quartz available upon request. Standard crucibles are available for both the Radak I and Radak II furnaces.



Crucible Liners

Some applications may require the use of an insert placed inside the standard crucible. Such applications include evaporating materials that would react with the standard crucible material, and evaporating melting materials that have a higher coefficient of thermal expansion than the crucible material. In these cases, a tough metal insert placed inside the standard crucible to form a crucible liner. Crucible liners contain the molten or reactive material within the standard crucible, protecting the furnace.

Crucible liners are available in the following materials:

- Molybdenum
- Tantalum
- Tungsten
- Nickel
- Special materials upon request



Figure 2: A variety of crucible liners are available

Specialty Crucibles

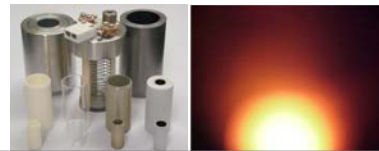
Some materials present specific challenges that cannot be overcome using a liner alone. For these applications we have developed material specific crucibles.

Organics

Organic materials tend to evaporate at relatively low temperatures. Our furnaces are designed to minimize material buildup at the lip of the crucible by applying more heat to the top of the crucible. Some organics such as ALQ3 and Copper phthalocyanine are evaporated at such a low temperature that the temperature at the lip of the crucible is insufficient to prevent re-depositing on the crucible. In extreme cases, this can lead to the evaporant blocking the mouth of the crucible. For these applications, we have developed a low temperature, high thermal conductivity crucible which effectively eliminates crucible choking. This crucible is for low temperature materials only and should not be used above 460°C.



Figure 3: "Organic" Crucible



Solar Cell Production

Materials used in solar cell production such as copper and selenium require special consideration. Due to thermal expansion, the Cu melt will cause the crucible to crack on cooling, which can destroy the furnace upon re-melting the source if not detected. To avoid this, we recommend using a molybdenum liner. The molybdenum liner for the Radak I has a 1cc working volume. The liner for the Radak II has a 6cc working volume. For higher volume production, a molybdenum crucible is available for the Radak II but is currently a custom order.

For Selenium deposition, we have developed a ceramic coated stainless steel crucible. The stainless is both compatible with the molten Se and tough to withstand expansion during heating and cool down. This crucible also features a reduced aperture to reduce potentially dangerous source spitting. For materials with a high propensity to spit, Luxel can provide custom designed crucible “baffles” which are installed over the crucible to eliminate line-of-sight between source and substrate. We will be happy to discuss your application requirements and design a solution for you.



Figure 4: Coated stainless steel crucible with reduced aperture for Selenium. Custom crucible baffles for spitting materials.

PBN Crucible

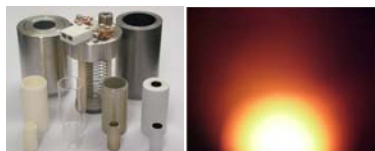
Luxel offers a Pyrolytic Boron Nitride (PBN) crucible. The high purity (99.9% pure) PBN crucibles have a nominal 2% taper over their length.

Please see our ever-growing table of crucible recommendations by material!



Product Datasheet:

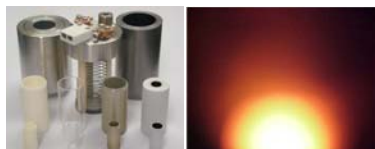
Crucible Selection Guide



Material	Symbol	Crucible	Liner (if required)	Melt °C	S / D	NOTES
ALQ3	ALQ3	Organic				
Aluminum	Al	PBN		660		
Antimony	Sb	Alumina		631	S	O,T
Arsenic	As	Alumina		814	S	O,T
Barium	Ba	Alumina	Ta	717		O,P,T
Barium Chloride	BaCl ₂	Alumina	Ta, Mo	962		
Beryllium	Be	Alumina	W	1284		
Bismuth	Bi	Alumina	W, Ta, Mo	271		T
Boron Nitride	BN	Alumina		2973	S	
Cadmium	Cd	Alumina		321	S	P,T
Calcium	Ca	Alumina		810	S	O
Calcium Fluoride	CaF ₂	Alumina	Mo, Ta	1418		
Cerium	Ce	Alumina		785		H
Cesium Iodide	CsI	Alumina		621		
Chromium	Cr	Alumina	W	1857	S	
Cobalt	Co	Alumina		1478		
Copper	Cu	Alumina	Mo	1083		
Copper phthalocyanine	CuPC	Organic				
Dysprosium	Dy	Alumina	Ta	1409		
Erbium	Er	Alumina	Ta, W	1522	S	
Europium	Eu	Alumina		822	S	O
Gadolinium	Gd	Alumina		1312		
Gallium	Ga	Alumina		30		
Germanium	Ge	Alumina		959		
Gold	Au	Alumina		1063		
Holmium	Ho	Alumina	Ta	1470		
Indium	In	Alumina		157		
Indium Tin Oxide	ITO	Alumina		1800	S	
Iron	Fe	Alumina		1535		
Lanthanum	La	Alumina	Ta, W	887		O
Lead	Pb	Alumina		328		T
Lithium	Li	Alumina		179		H,O
Lithium Fluoride	LiF	Alumina	Ni	845		
Lutetium	Lu	Alumina		1656		
Magnesium	Mg	Alumina		651	S	O
Magnesium Fluoride	MgF ₂	Alumina		1261		
Manganese	Mn	Alumina		1244	S	
Neodymium	Nd	Alumina		1021		
Nickel	Ni	Alumina		1455		
Palladium	Pd	Alumina		1555	S	
Phosphorus	P	Alumina		597	S	T,F



**Product Datasheet:
Crucible Selection Guide**



Polonium	Po	Quartz		254		T
Potassium	K	Quartz		64		F
Potassium Bromide	KBr	Alumina		734		
Potassium Chloride	KCl	Alumina	Ni	770	S	
Potassium Iodide	KI	Alumina		681		
Praseodymium	Pr	Alumina	Ta	931		
Rubidium	Rb	Quartz		38		F
Samarium	Sm	Alumina		1072		O
Scandium	Sc	Alumina		1397		O
Selenium	Se	Coated SS		217		T
Silicon	Si	Alumina	Ta	1410		
Silicon Monoxide	SiO	Alumina	Ta	1702	S	
Silicon Nitride	Si3N4	Alumina		1900		
Silver	Ag	PBN, Alumina	Mo	961		
Sodium	Na	Quartz		98		F
Sodium Fluoride	NaF	Alumina		993		
Strontium	Sr	Alumina	Mo, Ta, W	771		O,F
Sulfur	S	Quartz		597	S	P
Tellurium	Te	Alumina	Ta, W	450		T
Terbium	Tb	Alumina		1360		
Thallium	Tl	Alumina		304		T
Thullium	Tm	Alumina		1545	S	
Tin	Sn	Alumina		232		
Tin Oxide	SnO2	Alumina		1630	S	
Titanium Oxide	TiO	Alumina	W, Mo			
Tungsten Oxide	WO3	Alumina		1473	S	
Victawet	VW	Alumina				
Ytterbium	Yb	Alumina	Ta	824	S	
Yttrium	Y	Alumina		1477		
Zinc	Zn	Alumina		419	S	P

NOTES:

H = Hygroscopic films

O = Oxidizes quickly in air

T = Toxic

F = Flammable in air

P = Poisonous to vacuum systems due to low sticking coefficient

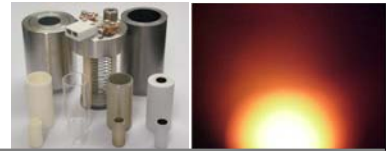
S = Sublimes

D = Decomposes

Figure 5: Luxel crucible and liner recommendations by material



**Product Datasheet:
Crucible Selection Guide**



Disclaimer

Given the range of materials and possible deposition combinations, all crucibles have not been tested for every application. Luxel has many years of experience evaporating numerous materials and our technicians will help guide you in your crucible/ liner selection however, it is ultimately the responsibility of the end user to verify compatibility with their specific application.

Crucible Options by Radak Furnace			
	Radak I	Radak II	Radak III
Crucible Size	1”H X 0.495” OD – 2cc	2”H X 0.995” OD – 15cc	3.91”H X 1.96” OD – 140cc
Usable Capacity	1cc	10cc	100cc
Materials	Alumina, Quartz, PBN, Coated Stainless Steel, Organic		
Liners	Molybdenum, Nickel, Tantalum, Tungsten		Special Request only
Liner Capacity†	0.5cc	6cc	

Maximum Operating Temperature

Please note that the maximum operating temperature of the Radak furnace with the radiation baffle installed is 1500°C. Exceeding the maximum operating temperature of the furnace or the crucible will void the product warranty.

Crucible	Maximum Operating Temperature (°C)
Alumina	1500
PBN	1500
Quartz	1000
Coated Stainless	900
Organic	460