



Fermi National Accelerator Laboratory

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Materials for Ultra-High Vacuum

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It is very important to use proper materials in any vacuum system, especially where a pressure of 1×10^{-9} Torr or lower is desired.

Most plastics have high vapor pressure, but some metals do, too. Zinc and cadmium are very bad, and zinc will also "poison" any cathodes and other high voltage surfaces. For these reasons you must not use brass and improper brazing alloys.

Most common brazing alloys contain zinc and cadmium but there are high vacuum alloys available that work just as good and do not contaminate a clean vacuum system. The silver-copper eutectic is excellent and is known by various names such as Cusil, BT, and Aircosil M. It has a relatively high melting point of 778°C , so brazing fluxes cannot be used. A hydrogen torch or a heliarc welder can be used for joining copper with this alloy. It is a FNAL Stock Item.

WESCO recently came out with an alloy called Cusiltin that is copper, silver, and tin. It has low vapor pressure and the melting point is very near that of common 35% silver alloys. It works quite well with paste brazing fluxes, and is available in sheet and wire forms. It is a very good vacuum material.

Soft solders such as 50-50 or 60-40 (TIN-LEAD) are usable in vacuums that do not have to be baked at high temperature, since the melting point of 60-40 is about 180°C . However, a better soft solder for vacuum is a tin-silver eutectic 95-5. It eliminates the higher vapor pressure lead, and a higher melting point of about 230°C allows systems to be baked up to 200°C . There is also a 95-5 solder alloy of tin and antimony. Antimony has about the same vapor pressure as lead, so be sure to get the tin-silver.

Instead of soft solder, consider other connection methods such as screw clamps, heliarc welding, and spot welding where such joints are possible.

Do not use brass! Check all bolts and nuts with a magnet to be sure they are stainless steel, and not cadmium plated steel! Good high vacuum materials are:

stainless steel	moly, tungsten, tantalum, etc.
nickel alloys	silver, gold, platinum
nickel (it is magnetic)	silver-copper eutectic solder
OFHC copper	silfos solder
titanium	phosphor bronze
niobium	Cupro nickel
alumina ceramics	beryllium, beryllium copper
machinable ceramic	glass
vacuum degassed steel	

Vacuum degas steel, stainless steel, and titanium to remove trapped hydrogen.

Use ceramic for insulators where possible, try to eliminate G-10, teflon, G-30, and kapton. Remove all soft solder or brazing fluxes if used, and handle all parts with clean nylon gloves.