

Subject: Re: L080045: Limits to high vapor pressure elements in alloys

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LIGO-L080045-00

Limits to high vapor pressure elements in alloys for LIGO UHV components

To the Vacuum Review Board (VRB):

The current LIGO Vacuum Compatible Materials List:

<http://www.ligo.caltech.edu/docs/E/E960050-B/E960050-B.pdf>

states that phosphor bronze is an acceptable material. According to typical UHV practice alloys containing cadmium, lead, phosphorous, selenium, sulfur and zinc are not considered UHV-compatible (e.g. O'Hanlon, A User's Guide to Vacuum Technology, 2nd ed., p. 280). However, many alloys considered acceptable contain some, albeit small, levels of these elements. For example, Aluminum alloy 6061 is considered an acceptable UHV alloy by O'Hanlon and it contains a maximum of 0.25% Zn; 304 Stainless Steel contains up to 0.045% P and 0.03 % S. Based on an analysis (in the attached technical memo T080106-00) of the outgassing rates for these high vapor pressure elements in alloys, a conservative estimate of the deposition rate onto sensitive optics and a criteria for the maximum allowable deposition thickness (1 nm in 10 yrs), I recommend the following:

- 1) Alloys with maximum of Cd, Pb, P, Se, S or Zn < 0.05% are acceptable for UHV service and standard vacuum bake processing.
- 2) Alloys with P, Se, and S > 0.05% are never acceptable.
- 3) Alloys with maximum of Cd, Pb or Zn <= 5% may be proposed for review by the Vacuum Review Board (VRB), with sufficient justification (i.e. no reasonable alternate materials/parts).
- 4) Phosphor-Bronze alloys with P <= 0.35 %, Pb <= 1%, Zn <= 1% are acceptable for UHV service at 1 m or more from any optics, when the surface area is limited to $\sim 10^3$ cm² with sufficient justification (i.e. no reasonable alternate materials/parts). However these parts must be air baked (not vacuum baked) and require FTIR (not RGA) qualification.

Are these reasonable/acceptable recommendations? Can we accept even higher levels of lead, for example up to 10% and thereby allow some bronzes in vacuum? Can we permit even more P in phosphor-bronze and open up the choices of available alloys?

Dennis

T080106-00.pdf

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