

**From:** Mark.Gross@csiro.au  
**Subject:** RE: Beamsplitter coatings  
**Date:** February 27, 2013 at 3:01 PM  
**To:** billingsley\_g@ligo.caltech.edu  
**Cc:** Phil.Martin@csiro.au



Hello GariLynn,

I don't know the vintage of the XL file you have but it seems to be a bit old.

The BSHR coatings are basically close, but the BSAR is not.

The latest numbers are as follows:

	BS-HR-44.97	BS-HR-45.76	BS-AR
IBSTAO	104.97	108.0	310.9
IBSSIO	263.76	259.2	181.0
IBSTAO	104.97	108.0	48.0
IBSSIO	263.76	259.2	336.1
IBSTAO	104.97	108.0	
Total thick	842.43	842.4	876
Total TaO	314.91	324.0	358.9
Total SiO	527.52	518.4	517.1

This makes your last table basically consistent as the CP thicknesses are correct.

The conclusion about thin tantala layers being sandwiched between oxygen poor layers has its deficiencies.

First, the 'oxygen poor' silica layers are present in every coating since it is the same 'formula' for every deposition.

This suggests that, if the above is true, oxygen scavenging at the interfaces by the silica material only affects thin tantala not thick – I cannot think why this would be so.

Second, the complete oxidation (by heating in air) of (sometimes quite thick) deposited layers of pure tantalum metal into tantalum pentoxide has been shown to proceed quite quickly and at quite low temperatures (300-400C) by a number of studies. This suggests that even if the tantala were oxygen deficient, annealing should readily fix it. I assume that silica may behave similarly, but perhaps not, although all of our examinations of lossy coatings has suggested the loss is in the tantala, not the silica.

Some recent experiments by our student here have been interesting in as much as she has not obtained a decent loss result (ie less than ~1.5 ppm and often much worse) in over 40 samples, regardless of the various cleans, coating thicknesses, annealing temperatures etc that she has tried – that is, not until she moved the annealing from an older laboratory muffle furnace into our new large annealing oven – suddenly, she is getting more good results (< 1ppm) than bad ! You may recall our past comments about the environment in these ovens and I think that this is one more reason for us to look very, very carefully into this.

Rgds,

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**From:** GariLynn Billingsley [mailto:billingsley\_g@ligo.caltech.edu]  
**Sent:** Thursday, 28 February 2013 7:41 AM  
**To:** Gross, Mark (CMSE, Lindfield)  
**Subject:** Beamsplitter coatings

Hi Mark,  
I need a consistency check. I think I have conflicting information on the BS AR design.  
First is the excel file that I have as the "official" design.

	BS-HR-44.97	BS-HR-45.76	BS-AR
IBSTAO	107.15	111.15	46.83
IBSSIO	256.01	251	145
IBSTAO	107.15	111.15	337.09
IBSSIO	256.01	251	305.64
IBSTAO	107.15	111.15	
Total thick	833.47	835.45	834.56
Total TaO	321.45	333.45	383.92
Total SiO	512.02	502	450.64

Next is a summary of some notes I was taking as we were exploring the difference between the CP and BS top two layers:

	Ta	Si
CP	43	244
BS	44	344

Our suspicion on the high BS absorption was that the thin Ta was sandwiched between two oxygen poor Si layers.

Which is correct? Or are they consistent in a way I am not understanding?

Thanks,  
GariLynn