Minutes of the Core Optics Subgroup, 3/14/02

9 am PST US/Europe meeting

UF: David R.
CIT: GariLynn, Helena, Bill, Ricardo
MIT: Gregg, David S.
Glasgow: Jim, Peter S., David C.
Stanford: Roger, Sheila, Vlad, Norna

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1) Coating Status (Helena)

- MLD is currently working on a Ta_2O_5 / Al_2O_3 coating run.

- Given the results of the coating Q measurements (see Shiela's and Gregg's report below), a detailed discussion of the next phase of the coating research took place. Should we continue to explore a variation of parameters of the current Ta/silica coatings or move to looking at new coating materials (Zr,Nb,Hf)? Gregg suggested that we use MLD for exploring different materials (since they are already doing this for optical loss) and continue to use Lyon for parameter variations.

- Along those lines, a teleconference between Gary DeBell of MLD and some of the core optics folks took place Friday, 3/15, to explore the following questions (thanks to Sheila for her outline of the discussion):

  - Issues/practical constraints on making a high reflectance coating with a large number of multiple low index (Al2O3/SiO2) layers
  - What (complete) set of materials do we have to choose from which seem suitable for use in 1 micron low optical loss coatings.
  - Annealing issues: what practical constraints are there in terms of annealing the coatings to high temperatures. How do these constraints vary for different materials/coatings.
  - At what thickness does laying down a single layer of a material become a problem (ie: does coating material morphology typically change at some thickness? etc)

- Jean Marie Mackowski will come to CIT on 3/25,26 to discuss future coating runs.

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2) Polishing Status (Gari)

- CSIRO has sent CIT a report about their results on compensating polish of sapphire. The report is available at http://docuserv.ligo.caltech.edu/docs/internal/C/C020136-00.pdf
A summary for the ion beam etch:

  - depth resolution of a few nm
  - up to 100 nm depth; can maybe do more
  - etch rate from ~0 – 200 nm/min

- in the polished areas, the microroughness is *better* after the compensating polish
- slope of the polish is dz/dx = 90nm/mm

Question (David S.): Does the ion beam etch screw up (or improve or change in some way) the Q of the substrate? Worth looking into.

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3) Absorption (Roger)

- Sapphire:
  - 1600 C furnace up and running; CS sapphire currently undergoing long term bake.
  - Vlad looking at previous sapphire measurements to gauge repeatability.

- Coating Absorption
  - several of the MLD coatings runs have been sent to Stanford (9 each of Nb,Zr,Ta coatings).
  - Vlad has developed a standardization method using a Newport ND 0.6 absorbing filter for getting absolute values for data. In addition, a previously measured Lyon-coated piece has been sent as a check; Stanford gets 0.72 ppm when prior measured value was 1.2 ppm. Doing multiple measurements is the key to getting good data.
  - Results:

Material	*Coating Anneal Temperature (C)*	*Measured Absorption (ppm)*
Zr	300	22
	350	19.5
	400	12
Nb	300	1.2
	350	0.75
	400	0.42
Ta	250	1.7
	300	1.2
	350	0.75

  - localized ‘hot spots’ observed; need get surface maps going.

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4) Q measurements (Sheila, Gregg)

Again, directly from Shiela:

“An update on where we are with the 3 inch by 1 inch fused silica coating samples. The results consistently point in one direction and might be useful to consider before the LSC meeting.

We have now completed mechanical loss measurements and for the most part, the analysis, of all the coated 3" by 1" fused silica samples so far. Our results are in many ways encouraging and are consistent with the following pattern:

(a) The first interface of the fused silica substrate and the coating is not a significant source of loss
(b) The individual multi-layer interfaces with the coating are not significant sources of loss
(c) The most significant source of loss is within the coating materials themselves
(d) The tantalum pentoxide in the coatings is significantly lossier than the silica in the coatings.
(e) Putting this extra info into our previous measurements on aluminum oxide/tantanlum pentoxide coated samples suggests the aluminum oxide has a loss smaller than silica.

This suggests strongly that we should now aim our experiments at investigating the mechanical loss of different optical coating materials - this needs to be co-ordinated with the ongoing optical loss measurements of different materials

Both silica and alumina are materials used for the low index portion of a coating, so the obvious target is to concentrate on finding a high index material of low mechanical and optical loss. The optical losses of Nb2O5 and ZrO2 are already being studied at Stanford and preliminary measurements suggest Nb2O5 is the significantly better option. Other materials like Halfnia and Titania are possibilities.

In fact it is possible to make coatings of alternate layers of low index materials - however one needs many more layers to get the high reflectivity needed. This highlights a trade-off that is necessary - which involves studying the number of layers needed of a material of particular index and mechanical loss.

We thus propose that we develop a plan to target the study of the losses of different materials. However this needs some technical input from our coaters - J-M Mackowski and G. DeBell. e.g., it would be most efficient to simply lay down on a substrate a thickness of a given material equivalent to say 30/4 lambda and get a straight measure of the material loss. However as Marty points out, it is not clear that the morphology of this thicker coating would be the same as for the individual thinner multi-layers and this is an area where feedback from J-MM and GDB would be very helpful."

- Gregg at MIT reports similar trends to what Peter and David have measured; they have also identified some spurious modes and are now playing around with David C's loss code.

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5) Wrap up, upcoming deadlines

- LSC Meeting
- Next month, the Core Optics group will try pre-meeting reporting to brief all ahead of time.

5:30 pm PST Telecon

UF: Dave R.
UWA: David B., Ju Li, John Jacob

Gingin: Zhou, Yonglan

- UWA: test mass suspension system now in place; full control of test mass (all DOFs) using electrostatic actuators. Using 2” mirrors mounted in aluminum as the test mass pieces.

- thermal moise modeling underway.

- the UWA group is looking at novel suspensions based on different geometries.