Materials for ET-LF

Core optics and Suspensions

ISB WORKSHOP OCTOBER 2022 – PARALLEL SESSION 1

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Summary Part 1

PARAMETERS:

Synergy between ET-LF and Virgo Next:

- Several materials that are suitable for room temperature applications will be suitable also for cryogenic temperatures
  [nitrides, crystalline coatings (AlGaAs, Oxides), …]
- The R&D needed to improve the deposition process.

We have to define the missing R&D and separate the measured parameters from the desired ones to achieve the sensitivity of the ET.

- A new database will be created.

Comment: we need to measure the effect of the charge on small core optics samples

AlGaAs:

This is a very promising material, but we cannot forget that temperature affects several subsystems and a cryogenic temperature is required to meet the sensitivity of the ET.

ICE LAYER:

We are learning from KAGRA and will avoid designs that favour ice formation.
Gas flow simulations show that for H2O, flow to the mirror will not be a crucial problem.
(1 molecular layer after 2 years).

Summary Part 2

GEOMETRY

Cylindrical vs. rectangular ribbon

- Dilution factor: to be optimized (aspect ratio, neck, length, diameter and so on)

- Surface treatments: different treatment for the different => breaking strength, surface loss angle, thermal conductivity

LENGTH

Decided to be **1.2 m** long (cryostat dimensions)

- Some techniques (U. Gibson silica clad silicon, potentially crystal growth) show these lengths are achievable

- Cutting/griding these lengths potentially possible from silicon boules (expensive)

- Increase stress > decrease vertical frequency > pushes vertical mode down.
  - *e.g.: for 40 MPa ribbon (5:1 ratio), vertical around 40 Hz, at 80 MPa, this gets pushed down to around 29 Hz into LF detection band*

Summary Part 2

SAFETY FACTOR = 6

- State-of-the-art to be improved in the future
  - improving production and surface treatment => higher breaking strength and reduced spread
  - improving the assembly technique and better evaluating allowable misalignment margins
    - avoid silicon rods breaking
    - do not underestimate difficulty handling and working with silicon suspensions
    - Impact on dilution factor

JOINTING METHODS

- Jointing methods will ultimately drive design
- Modelling of suspension energy distributions: optimize the size of the jointing part to reduce the energy => reduce the losses