1. Motivation

For current gravitational wave interferometers, the limit in sensitivity at their most sensitive frequencies originates from the thermal noise, dominated by the loss angle of high refractive index material. As part of a new coating characterization laboratory at Maastricht University, a gentle nodal suspension system has been built. We will present initial studies of the mechanical loss of different compositions of TiO$_2$ doped with a few percent of GeO$_2$ as part of a comprehensive study of the effect of composition and heat treatment on loss and absorption of magnetron-sputtered germania-based coatings.

2. Gentle Nodal Suspension (GeNS) system

- GeNS system: the sample is suspended on the top of spherical surface, inside the vacuum tank [1].
- Only applied force is its weight, no external damping.
- A non-contacting electrostatic actuator can excite the characteristic mode vibrations of the sample.

2.1 the Samples

- 2x PIAD EBE (electron beam evaporation) coatings made by Helia Photonics:
  - 1. 85% TiO$_2$ and 15% GeO$_2$
  - 2. 95% TiO$_2$ and 5% GeO$_2$
- for reference: 3x uncoated SiO$_2$ substrates 50mm x 1mm, heat treated @ 900$^\circ$C for 4hrs.

3. Uncoated Loss

- Test for the repeatability of GeNS.
- Characterization of SiO$_2$ substrates of same geometry of the coated germania samples.
- Visible trend of the loss angle as a function of the modes family for each disk.
- Mean value for the loss angle at (2.2 ± 1.0) × 10$^{-7}$.

5. Results

- Previous studies on ZrO$_2$:Ta$_2$O$_5$ and heat-treatment showed the mechanical loss correlated with fraction of corner sharing in the amorphous structure [2].
- Loss level of coated disks very consistent for all the modes.
- Lower loss of 15% Ge-doped Ti coating due to different layer thickness.
- 5% Ge-doped Ti as-deposited give loss angle at 8.8 × 10$^{-4}$ ± 2.0 × 10$^{-7}$.
- 15% Ge-doped Ti as-deposited give loss angle at 9.1 × 10$^{-4}$ ± 3.1 × 10$^{-7}$.

6. Current status and next step

Done:
- Characterization of uncoated SiO$_2$ substrates.
- Mechanical loss measurement of 85% and 95% TiO$_2$:GeO$_2$ as-deposited.

To do:
- Explore the effect of heat treatment on the same doped samples.
- Further investigations on germania doped titanium samples in different concentration and different geometry.

References: