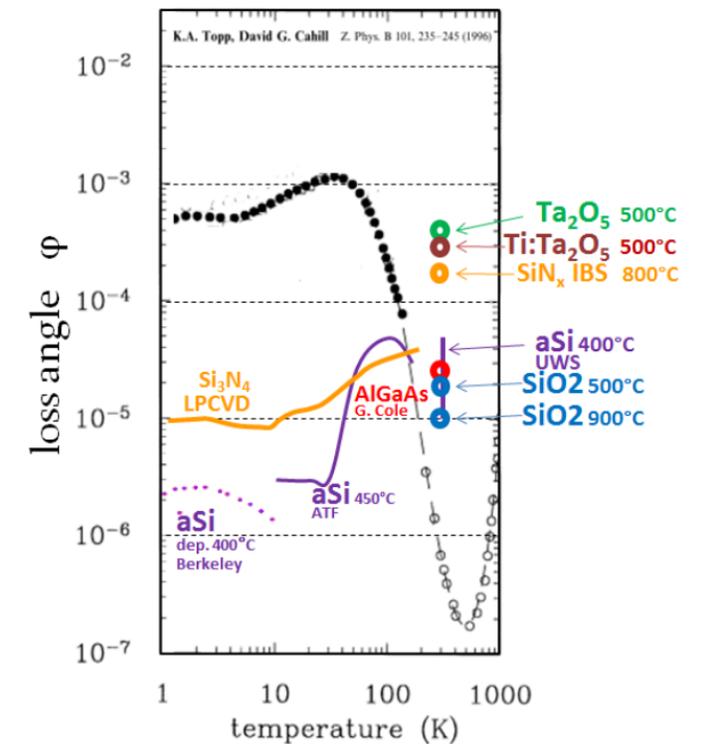


Optical and mechanical characterization of ion-beam sputtered MgF_2 and AlF_3 thin films

A lot of effort has been dedicated to find an alternative high-index material that is the most dissipative one at room temperature.

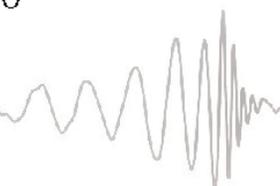
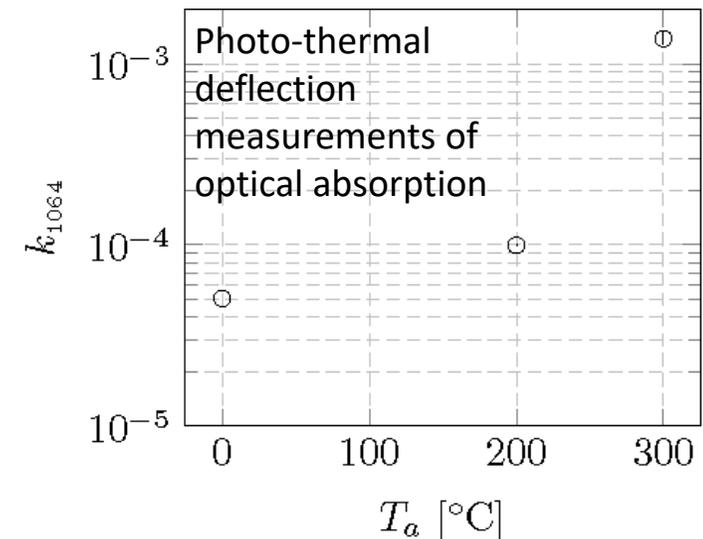
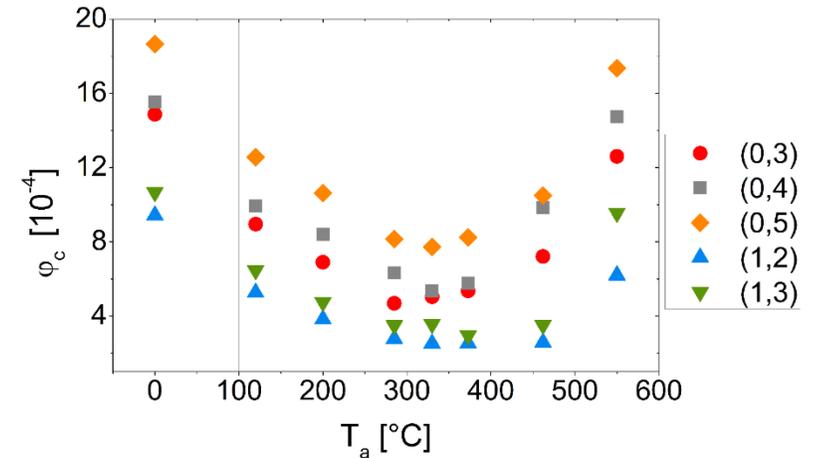
For cryogenic GWDs like KAGRA, ET and Cosmic Explorer there is a need to find alternative materials. In fact, silica shows a dramatic increase of dissipation at low temperature and should be replaced by another low refractive index material featuring low mechanical losses and low optical absorption.

Fluorides have the lowest refractive index among the known coating materials and could be a valid option for use in cryogenic GWDs. Up to now we have characterized fluoride coatings at room temperature.



Conclusions: AlF₃

- From a mechanical point of view, the best annealing temperature lays between 285 and 373°C and a duration of 10 hours at the plateau temperature is sufficient to reach a minimum in the loss angle around $\varphi_c \cong 2 \times 10^{-4}$. However it's still higher than a silica coating at room T.
- From an optical point of view, the optical absorption increases after each annealing treatment. The minimum measured value for the extinction coefficient is $k = 5.1 \times 10^{-5}$ that is higher than tolerable for GWDs. Absorption could be related to the formation of colour centres, to the presence of roughness or to a poorly stoichiometric structure of the coating. The refractive index results to be 1.357, that is 7.7% lower than that of IBS silica layers.



Conclusions: MgF₂

- From a mechanical point of view, the best annealing temperature lays between 285 and 311°C and a duration of 10 hours at the plateau temperature is sufficient to reach a minimum in the loss angle around $\varphi_c \cong 3 \times 10^{-4}$. However it's still higher than a silica coating at room T.
- From an optical point of view, the thermal treatment that minimize the optical absorption is between 200 and 300°C. The minimum measured value for the extinction coefficient is $k = 8.0 \times 10^{-5}$ that is higher that tolerable for GWDs. Absorption could be related to the formation of colour centres, to the presence of roughness or to a poorly stoichiometric structure of the coating. The refractive index results to be 1.405, that is 4.5% lower than that of IBS silica layers.

