Development and test of an absorption bench to characterize the KAGRA mirrors

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ABSTRACT

The KAmioka GRAvitational wave detector (KAGRA) is a laser interferometer with 3km arms. It is aiming to detect the first gravitational wave in 2018. The main characteristics, compared with other detectors, are that KAGRA is located underground to reduce seismic noise, and the mirrors will be cooled down to 20K in order to reduce thermal noise. Sapphire mirrors will be used because of their good thermal conductivity at low temperature. The operation at cryogenic temperature depends strongly on the mirror optical absorption. For this reason it is important to measure and minimize this mirror parameter.

The experimental setup to characterize the bulk and surface absorption properties uses the photo thermal interferometer method: an IR high power laser (1064nm) periodically heats the sample; the thermal lens effect causes a periodical distortion of the He-Ne probe beam (632nm) and this is detected by a photodetector. Using proper calibrations, the optical absorption of bulk and reflective coatings is measured. Several silica and sapphire samples (up to 20mm of thickness) has been measured.

At low temperature, thermal noise mainly depends on the mechanical losses on the reflective coating of mirrors. To reduce mechanical losses, crystalline dielectric multilayer coating made of GaAs/AlAs has been proposed for future KAGRA upgrades. To this purpose the absorption of GaAs/AlAs coatings deposited on thin wafers needs to be measured.

To improve the calibration procedure, and for a better understanding of the absorption system, numerical simulations has been made. The solution to the heat equation for the samples has been calculated, and the propagation of the probe beam has been performed with an FFT code.

We are currently upgrading the system to measure also larger samples, up to ϕ220mm x 150mm, the size of KAGRA sapphire mirrors, and to measure the GaAs/AlAs crystalline coatings.