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Characterization of light scattering point defects in gravitational wave detector coating layers

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The high reflective mirrors of the gravitational waves detector LIGO & Virgo present in the coating many micrometer size defects that scattered the light in the interferometer. This scattered light induces a loss of the laser power of the order of a few tens of parts per million (ppm) and a phase noise because of the recombination with the main beam after reflection on the tube walls. This phenomenon limits the sensitivity of the detector and impacts the ability to detect astrophysical events. A reduction of the scattered light is thus required in order to improve the optical performances of the coatings for the new mirrors of the Advanced LIGO and Virgo plus upgrade. For this purpose a dedicated research line is in progress at LMA since 2018.

We studied the point defects for each material tantala and silica separately with monolayers deposited onto micropolished fused-silica substrates. We analyzed the impact of different parameters, such as the thickness, as well as the effect of a post-deposition annealing. The samples were measured with a dark-field detection system in order to compare the density and the size distribution of the defects. We pointed out that even if one material has a much larger defect density, both materials share some similarities. Moreover we noticed an outstanding improvement of the coating quality thanks to the post-deposition annealing.

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