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Mirror coatings for next-generation detectors: what do we need

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US-based next-generation gravitational wave detectors can currently be divided in two implementations: A# will feature 100 kg test masses and should operate at room temperature (RT), while Cosmic Explorer (CE) should feature even 320 kg test masses, and laser power reaching 1.5 MW in the arms, with its first incarnation operating at RT. In the former, sensitivity limits in the most sensitive frequency range will be dominated by coating thermal noise (CTN) if the dielectric Bragg reflectors (DBRs) consist of the amorphous materials used in current detectors, so solutions to radically decrease that noise must be identified. Various amorphous mixtures and treatments have been attempted, with some success, together with a deeper understanding of the features of a good material at the atomic scale, but improvements to the CTN by almost an order of magnitude are required to make it insignificant compared to other noises. We will discuss two approaches: the GaAs-based approach, and the one based on silicon-on-insulator (SOI). Then, because of its characteristics, especially the arm's length, the DBRs for the CE could consist of the current materials, but also because of its size, tolerances on mirror deformation will be much more stringent, and materials featuring absorption below 0.1 ppm might be needed, with very few defects, on mirrors that may have more than 800 mm in diameter. The question therefore arises: how to achieve that, how to measure low absorption and achieve it on such a large area without defects.

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