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Optical loss study of the cryogenic molecular layer using a folded cavity for future gravitational-wave detectors

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In the future cryogenic gravitational-wave detectors such as the ET and LIGO Voyager, a molecular layer formed on the cryogenic mirror surface can become one of the problems due to its optical loss. We theoretically estimated the optical loss induced by the molecular layer and revealed that the optical absorption induced by the molecular layer. In addition, we developed 10 K folded optical cavity to investigate the optical loss of not only the coatings but also the molecular layer. In this experiment we realized the cryogenic optical cavity with folded configuration for the first time ever, and proposed a cavity enhanced ellipsometry technique to characterize the thin cryogenic molecular layer. We will present the possible impacts of cryogenic molecular layer on future gravitational-wave detectors, and the way to solve this problem.

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