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The Virgo Coating Collaboration: research lines and preliminary results of a detailed study on thermoelasticity in crystalline materials

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The visibility distance of interferometric gravitational wave detectors is limited by mirror thermal noise at mid-range frequency, where the first coalescence GW signals have been detected and where many others are expected in the next future. In particular, for 2G+ and 3G we need to increase the performance of the test mass multilayer reflective coatings. The Virgo collaboration is setting a coating R&D group on many issues, including especially metrology (loss angle measurements, thermoelastic effect modeling) new materials (new oxides, nitrates, fluoride, new cosputtered mixing and nanolayered composites) completely characterized (optically, mechanically and morphologically), optimized deposition parameters with the aim of developing new coating materials and technologies for the AdVirgo upgrades and for future detectors. Another objective is to understand the losses in amorphous materials, framing coating research in the more general context of the physics of glasses and amorphous materials. One of the developed research lines is the study of thermoelastic damping in crystalline materials, that are promising candidates for cryogenic test masses and particularly suitable substrates for coating research. A detailed discussion on models, based on a semi-analytical calculation starting from the heat diffusion equation, for silicon and sapphire substrates will be reported. A new study on the changes in thermoelastic loss after coating deposition, with some preliminary results, will be also reported.

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