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A Novel Production Method of Millimeter-wave Absorber by a 3D-printed Mold

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For a high-sensitive detection of millimeter-waves, mitigation of stray lights coming from outside of view is essential. In particular, we use superconducting detectors for millimeter waves, e.g. cosmic microwave background (CMB). The mitigation of thermal radiations from the ambient temperature is critical. Therefore, a millimeter-wave absorber maintained at an ultra-cold condition in the detector system is important.
The absorber is required to have not only a high absorption rate but also a low reflectance on its surface. A periodical pyramid-shaped surface is known to be effective to obtain a low reflectance on the surface. This is because it makes multiple reflections between the pyramids. For the actual installation in the detectors, its thickness is desired to be less than ~1cm. Thus, the pyramid should be millimeter size and fabrication of the periodical pyramids is not easy.
3D printing technology has an advantage in the fabrication of the fine structure. Therefore, we propose a new production method of the absorber by using the 3D printer. We fill radio absorptive materials into a 3D printed mold which has the pyramid shape. Any material can be used as the pyramid shape absorbers. The absorber is installed inside the wall of the cryostat. In this case, it is difficult to adhere the absorber there because the matching in coefficients of thermal expansion (CTE) between the metal-wall and absorber is necessary. Therefore, we chose a two-component epoxy adhesive (Stycast2850FT) as absorber material. The Stycast2850FT is a conventional adhesive for aluminum in low-temperature experiments. It works as absorber and adhesive to the metal.
The absorber made by this method achieves a low reflectance ($<\sim 1\%$) in the millimeter range ($>\sim$ 100GHz). Its adhesive performance is confirmed by the thermal cycle tests; we dunked the absorber stuck on the aluminum plate into the liquid nitrogen.

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