W45b Ultra-high Precision CTE Measurement of SiC for Cryogenic Space Telescopes

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We present the results of high precision measurements of the thermal expansion of sintered SiC, SiC-100, intended for use in cryogenic space telescopes, in which minimization of thermal deformation of the mirror is critical, and precise information of the thermal expansion is needed for the telescope design.

The thermal expansion of the samples was measured with a cryogenic dilatometer, consisting of a laser interferometer, a cryostat, and a mechanical cooler. The typical thermal expansion curve is presented using an eighth-order polynomial of the temperature. For the three samples, the coefficients of thermal expansion (CTE), #1, #2, and #3, were derived for temperatures between 293 and 10 K. The average and the dispersion (1 σ rms) of these three CTEs are 0.816×10^{-6} and 0.002×10^{-6} K^{-1}, respectively. No significant difference was detected in the CTE of the three samples from the different lots. Neither inhomogeneity nor anisotropy of the CTE was observed. We performed a finite-element method (FEM) analysis of the thermal deformation of a 3.5 m mirror made of six segments. It was shown that the present CTE measurement has an accuracy that is sufficient for the design of the 3.5 m cryogenic infrared telescope mission SPICA (Space Infrared Telescope for Cosmology and Astrophysics).