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Thermo-mechanical testing results for IC-DX ultra-low thermal expansion alloy at cryogenic temperature

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Thermal shrink of materials is always an obstacle when designing cryogenic systems. In superconducting cavity cryomodules, some adopt reference bars, which are made by Invar, to keep cavities'position same at cryogenic temperature from room temperature. Linear expansion of Invar from 300 K to 2 K is about 0.04 %, resulting in approximately 5 mm of thermal shrink for the 12.6 m ILC cryomodule, for example. Since the less the reference bar shrinks, the better, our search for a new material led us to a material called IC-DX. It has 3˜4 times smaller thermal shrink than Invar and has about 180 GPa of Young's modulus at room temperature, which is 1.5 times larger than that of conventional Invar. It was known that IC-DX did not change to martensitic structure when cooled to cryogenic temperatures, but tensile tests, thermal conductivity measurements, and Charpy impact tests at liquid helium temperatures had not been conducted. In this study, tensile and Charpy impact tests were conducted at room temperature, liquid nitrogen temperature, and liquid helium temperature, and thermal conductivity measurements were conducted at 4-50 K. In this presentation, we report on these results.

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Footnotes

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