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Coolant-free Cryogenic Mechanical Property Test System with Optical Windows

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Digital image correlation (DIC) is a non-contact optical method for in-plane displacement and strain measurement, which has been widely accepted and applied in mechanical property analysis owing to its simple experimental steps, high accuracy and large range of measurement. However, it has been rarely used in cryogenic mechanical test since the opaque design of cryostats as well as interaction of optics with liquid coolants such as liquid nitrogen or liquid helium. In the present work, a coolant-free cryogenic mechanical property test system cooled by G-M cryocoolers, with a continuous, tunable environmental temperature from room temperature down to 2.7 K, was developed and tested. Two optical windows with a diameter of 100 mm made of quartz, which are compatible with the DIC technology, were designed on the cryostat and sample chamber. Surface displacement and crack-tip strain field of 316LN austenitic stainless steel were studied at 4 K by using this system. The results indicate that the test system with DIC technology can satisfy well for mechanical analysis of material at cryogenic temperatures.

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