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A cryogenic tensile testing apparatus for micro-samples cooled by miniature pulse tube cryocooler

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This paper introduces a cryogenic tensile testing apparatus for micro-samples cooled by a miniature pulse tube cryocooler. At present, tensile tests are widely applied to measure the mechanical properties of materials; most of the cryogenic tensile testing apparatus are designed for samples with standard sizes, while for non-standard size samples, especially for micro-samples, the tensile testing cannot be conducted. The general approach to cool down the specimens for tensile testing is by using of liquid nitrogen or liquid helium, which is not convenient: it is difficult to keep the temperature of the specimens at an arbitrary set point precisely, besides, in some occasions, liquid nitrogen, especially liquid helium, is not easily available. To overcome these limitations, a cryogenic tensile testing apparatus cooled by a high frequency pulse tube cryocooler has been designed, built and tested. Samples with a diameter of as small as 3 mm and thickness less than 1 mm can be tensile tested. The operating temperatures of the developed tensile testing apparatus cover from 20 K to room temperature with a controlling precision of ± 0.03 K and the whole deformation process of the specimen can be observed through a quartz window, which can be hardly realized by the way of liquid nitrogen or liquid helium cooling. The apparatus configurations, the methods of operation and some cooling performance will be described in this paper.

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Author: Mr CHEN, Liubiao (Technical Institute of Physics and Chemistry, CAS)

Co-authors: Prof. WANG, Junjie (Technical Institute of Physics and Chemistry, CAS); Mr GU, Kaixuan (Technical Institute of Physics and Chemistry, CAS); Mr LIU, Sixue (Technical Institute of Physics and Chemistry, CAS); Prof. ZHOU, Yuan (Technical Institute of Physics and Chemistry, CAS)

Presenters: Prof. WANG, Junjie (Technical Institute of Physics and Chemistry, CAS); Mr GU, Kaixuan (Technical Institute of Physics and Chemistry, CAS); Mr CHEN, Liubiao (Technical Institute of Physics and Chemistry, CAS)

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