DIC-enhanced experimental platform with a multi-detector array for tensile test at cryogenic temperatures

Jakub Tabin[1,*], Adam Brodecki[1], Adam Szyszko[1], Hubert Nejman[1], Zbigniew Ranachowski[1], Przemysław Wąchal[2]

[1]Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Poland
e-mail: jtabin@ippt.pan.pl

[2]Faculty of Mechanical Engineering, Cracow University of Technology, Kraków, Poland
e-mail: przemyslaw.wachal@doktorant.pk.edu.pl

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Material testing at cryogenic temperatures is essential for the development and validation of materials for energy, aerospace, and superconducting applications. Accurate characterization under such conditions requires experimental systems capable of stable operation at very low temperatures and synchronized acquisition of multiple physical signals.

This work presents a DIC-enhanced experimental platform with a multi-detector array designed for uniaxial tensile testing at cryogenic temperatures. The system enables tests at 4 K, 77 K, 300 K and integrates force and displacement measurements with full-field strain analysis using Digital Image Correlation (DIC). The experimental setup is equipped with a cryostat featuring an optical access window, allowing in-situ DIC measurements under cryogenic conditions. In addition, the platform incorporates acoustic emission (AE) monitoring and temperature sensing, with all signals fully synchronized in time.

The developed system enables quantitative characterization of deformation processes, including strain localization, plastic instability, and the evolution of deformation mechanisms at cryogenic temperatures [1, 2]. The combination of full-field measurements and multi-sensor data provides a detailed insight into the material response beyond conventional stress–strain analysis.

The proposed platform offers a versatile and reliable tool for advanced material characterization and supports the investigation of coupled thermomechanical phenomena in cryogenic environments.

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