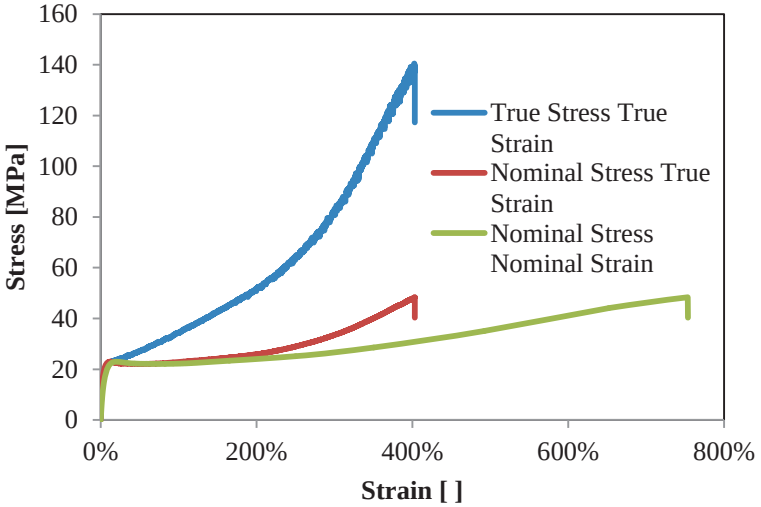
Cambridge Polymer Group

True Stress – True Strain Analysis

Summary

Proper characterization of a material's mechanical properties is critical for making appropriate design decisions. This is especially true for the growing field of computer simulation and modeling, which requires accurate inputs of material properties for techniques like finite element analysis.

The uniaxial tensile test, in which strain within the gage region is tracked with an extensometer is a common technique used for characterizing a material's mechanical properties. However, this technique assumes that the cross-sectional area of the test specimen remains constant during the test (the stress calculated as a result is referred to as "Engineering Stress" or "Nominal Stress"). In reality, however, substantial narrowing of the gage region is observed during tensile testing, meaning that the measured engineering stress is significantly less than the true stress in the material. As a result, using nominal stress and/or strain values as design inputs may lead to unexpected behavior.



Description

CPG has developed a high-resolution optical system for performing non-contact true stress true strain measurements during tensile testing. Two cameras are mounted normal to the front and side of the tensile specimen and continuously measure the specimen width, thickness, and axial strain as a function of time during tensile testing. The system has been validated to the criterial outlined in ASTM E83 for a Class B-2 extensometer and supports a wide range of fields of view. As an added benefit, the Poisson's ratio, defined as the negative ratio of transverse strain to axial strain, may also be calculated using this technique. The bottom left figure shows a comparison of the stress-strain data obtained from a single specimen of UHMWPE, using calculations for nominal stress/nominal strain, nominal stress/true strain, and true strain/true stress. Note that the true ultimate load is over 290% larger than the ultimate load as determined from engineering stress.

Key Points

- Determination of true elastic modulus, yield stress, elongation at yield, ultimate stress, elongation at failure, and Poisson's ratio.
- Meets criteria for class B-2 extensometer
- Automated synchronization with load frame.
- Non-contact measurement method that does not introduce additional loads or weak points onto specimen
- USB3.0 interface

Custom software designed by LabView™ certified CPG engineers

NATIONAL INSTRUMENTS

LabVIEW