

Summary

The elastic response of rubber-like materials is often based on the Mooney-Rivlin model, which describes the material's stress-strain relationship as a function of two empirically determined constants C_1 and C_2 . These constants are the two invariants of the deformation tensor. Knowledge of the Mooney-Rivlin constants for a particular material is of particular interest for groups performing finite element modeling of elastomers.

The determination of both C_1 and C_2 , however, requires biaxial deformation of the material and a measurement system capable of measuring stress and strain in this configuration.

Description

The CPG Mooney-Rivlin Apparatus performs biaxial deformation on a thin elastomer sheet via inflation. Based on the internal pressure and the changing positions of reference points on the sample surface, the stress and strain in the material is calculated.

The Mooney-Rivlin Apparatus consists of a gas delivery system and an optical measurement system. The bubble inflation is controlled by a pressure controller driven by a custom LabVIEW program. An external pressure transducer with a NIST traceable calibration record provides feedback for the pressure controller. The sample is monitored by an optical measurement system consisting of two identical CCD cameras mounted at 90 degrees to the sample to observe two axes of deformation. Each camera is calibrated by a dot grid imaged at the same magnification as the sample. The custom LabVIEW program tracks the positions of three reference points on the sample throughout the experiment and calculates the stress and strain for each frame. Afterward, the Mooney-Rivlin constitutive law is fit to the experimental data using a Levenberg-Marquardt χ^2 minimization subroutine.

Representative experimental images are shown in Figure 1, and a typical stress-strain curve with Mooney-Rivlin constants is shown in Figure 2.

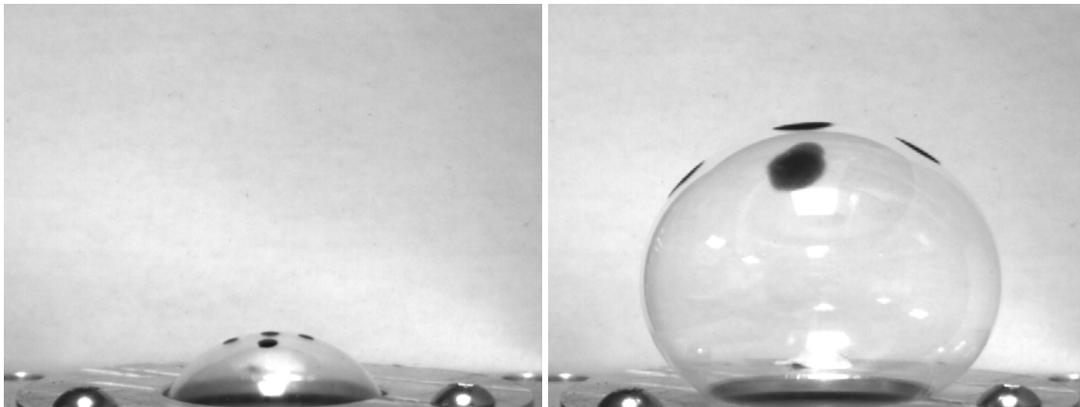


Figure 1: Representative images acquired during the bubble inflation experiment.

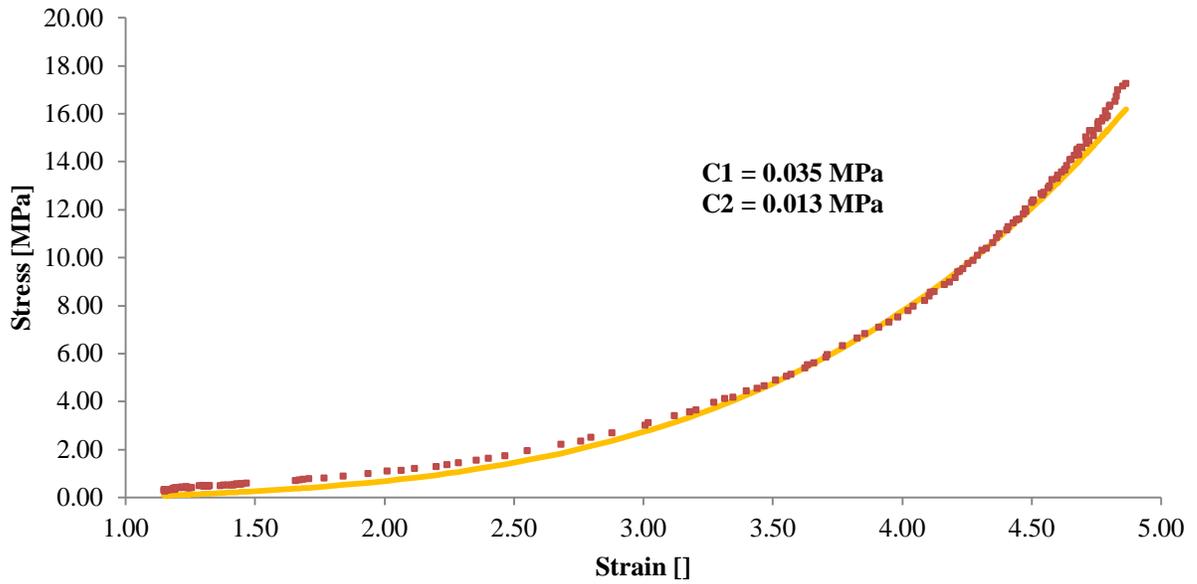


Figure 2: Typical stress-strain response of a rubber-like material. The red squares are experimentally measured data points, and the orange line is the best fit to the Mooney Rivlin constitutive law.