

Dynamic Testing Uncovers Rheology of Rubber

The Challenge:

Determine Level of Branching

in Uncured Rubber

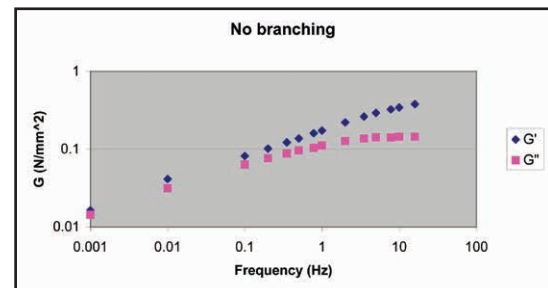
Background

Molecular weight, molecular weight distribution, and long chain branching of uncured rubber compounds are important parameters to understand for predicting the curing process and final material properties of cured rubber.

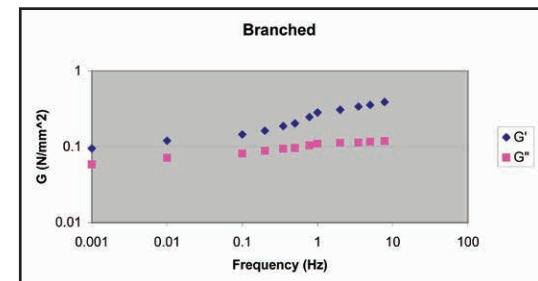


The ElectroForce® 3200 test instrument has been used to measure the dynamic shear moduli and tan delta of four uncured rubber compounds of Butyl rubber and carbon black.

These tests clearly show the amount of branching of each compound.



The compound with little or no branching exhibits a crossover of G' and G'' when plotted as a function of frequency. There is no crossover in the data from the highly branched material.



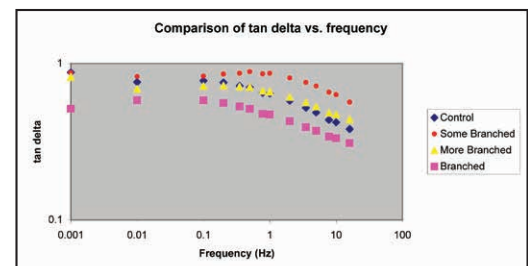
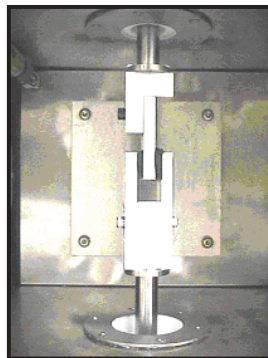
Also tan delta should decrease more at lower frequencies for branched materials as shown in the following figure.

Meeting the Challenge

The specimen was excited with a sinusoidal strain at an amplitude of 5% (0.2 mm peak to peak displacement) from 0.001 to 16 Hz (0.006 rad/s to 100 rad/s). Temperature was controlled to 125°C.

The test specimen was a double lap shear sample with thickness of 4 mm and 400 mm² area (20 mm by 20 mm).

The transmitted force was measured using a strain gaged load cell. Timed data was analyzed using an FFT to determine the amplitude and phase relation of the fundamental frequency at each test condition.



The ElectroForce 3200 instrument measures these properties as well as the properties of the fully cured rubber which makes it one of the most versatile material test systems in the industry.