Application of Depth-Sensing and Frequency-Specific Dynamic Indentation to the Measurement of Cure State Distributions in Elastomeric Materials

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A depth-sensing and frequency-specific dynamic indentation technique was used to determine the spatial distributions of dynamic moduli, including storage (E') and loss moduli (E''), in poly-cis-1,4-butadiene (BR) and brominated poly(isobutylene-co-p-methylstyrene) (BIMS) rubbers with varying degrees of cure and with or without carbon black fillers as a function of penetration depth. The BR rubbers were cured with sulfur and a sulfur accelerator and the BIMS rubbers were cured using zinc oxide and stearic acid. Spatially averaged bulk dynamic moduli thus determined using the nano-indentation technique was in general agreement with the tensile extensional and dynamic moduli measured from the bulk rubbers. Spatial distributions of dynamic modulus and its dependence on penetration depth were evaluated as functions of cure level and sample surface preparation for these BR and BIMS compounds.

The application of this technique in providing more detailed characterization of industrially relevant elastomeric materials across a broad cross-section of applications, such as, tires, automotive hose and belts, and electrical insulation will be discussed.