Characterizing the Intrinsic Strength of Natural Rubber / Butadiene Rubber Blends

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ABSTRACT. Tires require rubber compounds capable of enduring more than 10^8 deformation cycles without crack growth. One strategy for evaluating candidate compounds is to measure the intrinsic strength. The intrinsic strength is the residual strength remaining in the material after the strength-enhancing effects of energy dissipation in crack tip fields are removed. If loads stay always below the intrinsic strength (taking proper account of the possibility that the intrinsic strength may degrade with aging), then cracks cannot grow. Using the cutting protocol proposed originally by Lake and Yeoh, as implemented on a commercial Intrinsic Strength Analyzer, the intrinsic strength is determined for a series of carbon black (CB) reinforced blends of natural rubber (NR) and butadiene rubber (BR) typical of tire applications. The intrinsic strength benefits of the blends over the neat NR and BR compounds are only observed after aging at temperatures in the range from 50 °C to 70 °C, thus providing fresh insights into the widespread durability success of CB-filled NR/BR blends in tire sidewall compounds and commercial truck tire treads.

Keywords: fatigue, crack growth resistance, durability, tire sidewall compounds, TBR tread compounds, rubber testing, intrinsic strength

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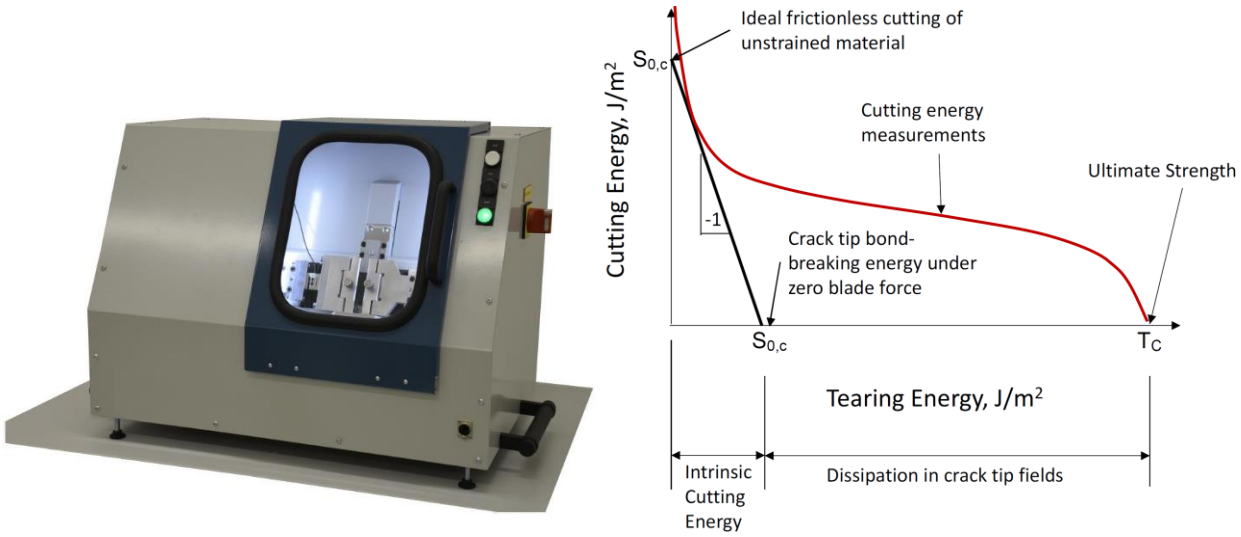
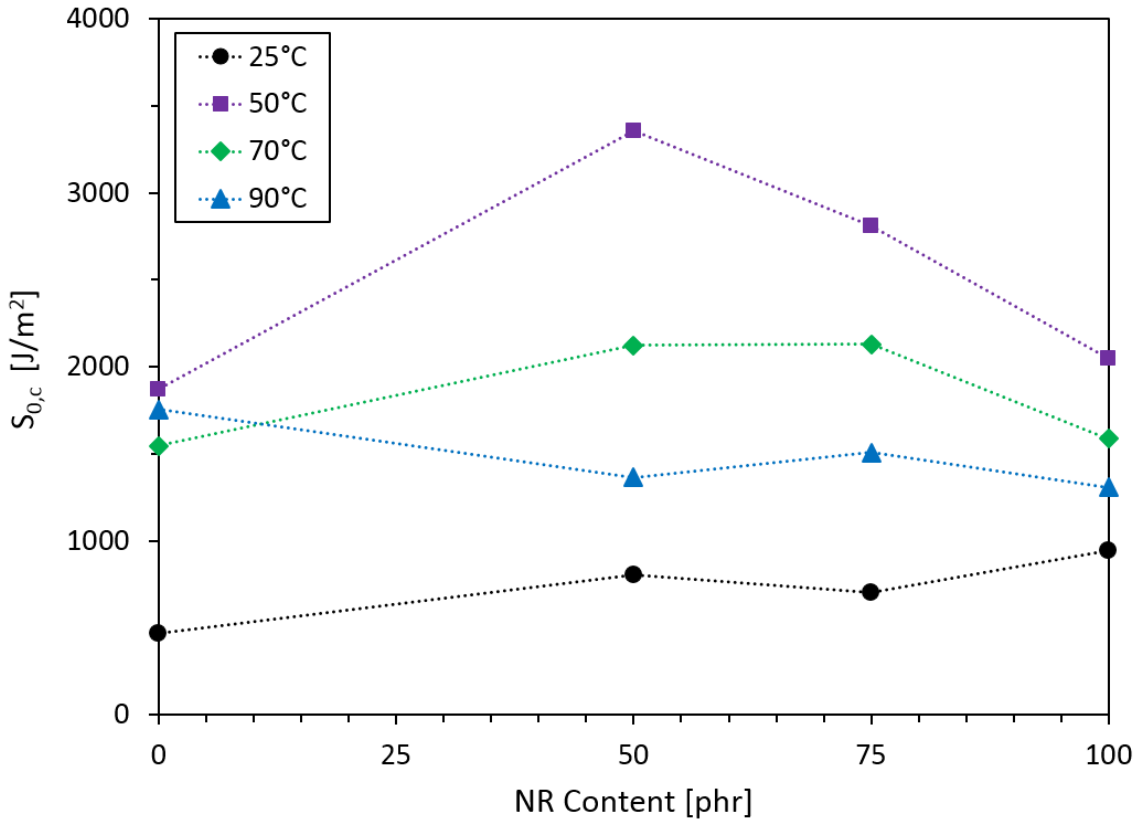
Citation: C. G. Robertson, R. Stocek, C. Kipscholl, and W. V. Mars, “Characterizing the Intrinsic Strength of Natural Rubber / Butadiene Rubber Blends”, Presented at the Annual Business Meeting and Conference on Tire Science and Technology, Akron, Ohio, September 12-13, 2017.



LEFT: Picture of the Coesfeld Intrinsic Strength Analyser. RIGHT. Method used to determine intrinsic cutting energy ($S_{0,c}$) from cutting energy versus tearing energy data.



Effect of NR/BR blend composition on intrinsic cutting energy ($S_{0,c}$) – which is proportional to intrinsic strength – after aging for 30 days at the indicated temperatures.