

Thermogravimetric and Fourier-Transform Infrared Spectroscopic Characterization of Tread and Reinforced Rubber Compounds in Commercial Electric Bicycle Tires

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Abstract:

The electric bicycle (e-bike) market is growing and demands tires with better puncture resistance, improved wet and dry grip, and optimized rolling resistance. A comparative characterization of the tread (black) and reinforced-layer (colored) rubber compounds from three leading commercial e-bike tire brands, referred to as Sample A, Sample B, and Sample C, was performed using thermogravimetric analysis per ASTM D6370 and Fourier-transform infrared spectroscopy. TGA decomposition profiles were used to quantify the volatile matter and fractions of polymer, carbon black, and inorganic filler, whereas FTIR fingerprint analysis was used to determine the base polymer types. All three tread compounds utilize an NR/SBR blend; however, substantial filler loading difference (carbon black from 6.9 to 30.4 wt.% and inorganic matter from 16.9 to 20.5 wt.%) with hardness varying between 57 and 75 Shore A reveals different design philosophies among these products. The reinforced-layer compounds showed even greater compositional diversity wherein Sample A used pure NR with low filler, while Sample B contained a high inorganic filler content of 36 wt.%. The FTIR spectra could clearly differentiate between NR-only compounds and those containing an SBR blend based on the presence or absence of certain absorption bands for aromatic C–H and phenyl rings. These results can be used as a quantitative benchmark for the development of next-generation reinforced e-bike tire compounds.

Keywords:

Electric bicycle tire, TGA, FTIR, rubber compound.