Eco-efficient friction materials

Submitted by Michael Robert Sloan, to the University of Exeter as a thesis for the degree of Doctor of Philosophy in Engineering July 2008

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............................
Abstract

Automotive friction materials are multi component composites in which fibrous materials play a fundamental role. Modern friction formulations have been developed around asbestos fibres, a heavily used material before legislation outlawed its use in the 1980’s. The replacement adopted by the friction industry was aramid, a high performance, high cost synthetic fibre.

The work in this thesis investigates the role of aramid fibres in an economy friction material from the early mixing stages in manufacture using mechanical and optical analysis techniques through to the friction and wear performance of brake pads by employing instrumented friction and wear machines. Experimental procedures were designed and employed to quantify the performance of aramid pulp within the friction formulation as a function of volume fraction. Investigation showed a hierarchal fibre structure produced by an inherent molecular structure that encourages fibrillation producing complex fibre morphologies. This physical structure has been identified as fundamental to the success of aramid pulp in friction materials as the fibre network readily entraps small particles aiding the manufacturing process of friction materials. A structural model has been developed to describe both the particle retention performance of aramid fibres and the bulk structure of the pulp as a function of fibre geometry.

A dynamic mechanical test was used to measure the bulk elastic properties of fibre networks to assess their suitability as processing fibres in friction materials and providing a novel analytical technique for the friction industry.

Hemp, flax and jute are examples of high performance natural fibres that offer a significant cost saving over aramid, representing candidate replacements. Various natural fibres were trialled in friction formulations as direct replacements and also blended with aramid pulp. The results are compared to the baseline specification produced for aramid pulp allowing the suitability of natural fibres in friction materials to be discussed.
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