FRICTION PROPERTIES OF HEAT TREATED NATURAL CARBON MATERIALS AND SYNTHETIC MATERIALS

C. M. A. Girelli, J. C. C. Freitas, A. G. Cunha and F. G. Emmerich
Departamento de Física, Universidade Federal do Espírito Santo
29060-900 Vitória, ES, Brazil

Introduction

The objective of this work is to make a study about heat treated natural carbon materials, from the point of view of their friction properties, and compare them to synthetic materials. The natural material used was the endocarp of babassu coconut, which is native from Brazil and it was chosen because of its peculiar structural properties [1-3]. This material was heat treated in an inert atmosphere (carbonized) up to temperatures of 250, 300, 500, 1000 and 1200°C. The synthetic material used for comparison was an automobile brake pad, available in market nowadays. Measurements of the coefficient of kinetic friction, wear rate, thermal conductivity, and specific heat were performed.

Experimental

Details of materials and heat treatments are given elsewhere [4]. Part of the measurements of coefficient of kinetic friction and wear rate was made in a normalized equipment (F.A.S.T. - friction assessment screening test) of a brake industry. A simpler equipment, which allows similar measurements, was also developed in our laboratory. This apparatus consists in a brake disc, coupled to a motor which makes it to spin. The samples were pressed into the disc by a normal force, during 10 minutes, and then the motor was powered off. The time necessary for the disc to attain the rest was measured, as well as the volumetric variation of the sample. A simple mechanical model was proposed, which was satisfactory to calculate the coefficient of kinetic friction from the time to attain the rest. The tests were made under different normal forces, in order to enlarge the range of friction forces studied. The measurements of specific heat were performed by a differential scanning calorimeter (DSC-50) and the measurements of thermal conductivity by the laser flash technique.

Results and Discussion

Although the samples with HTT up to 200°C present good mechanical properties, they are not appropriate for the application in automobile brake systems, because they present very high wear rates and they are not thermally stables.

The samples with HTT of 250 and 300°C possess coefficients of kinetic friction of the order of 0.25 (Fig. 1), wear rates inferior to the one of the brake pad (Fig. 2 and 3), and low thermal conductivities.

The 500°C HTT samples presented the largest coefficient of friction (0.31) and the smallest wear rate among the analyzed chars. However, they possess some disadvantages: low thermal conductivity and a certain fragility.

The 1000 and 1200 °C HTT samples, in spite of presenting thermal properties superior to those of the brake pad (Fig. 4 and 5), present coefficients of friction inferior and wear rates superior to those of the other chars, and, above all, they are extremely brittle.

Conclusions

The studied chars presented coefficient of kinetic friction and mechanical properties inferior to those of the commercial brake pads. On the other hand, in certain HTT ranges the chars were superior in other properties such as wear rate, thermal conductivity and specific heat. However, the main limitation for the use *in natura* of these chars is their fragility (low toughness), which affects noticeably the samples with HTT equal or superior to 500°C. A possible option is to make use of them in composites or associated with other materials in order to minimize their fragility.

References

1. Emmerich FG. PhD Thesis. 1987. Universidade Estadual de Campinas, Brazil.
2. Emmerich FG et al. Carbon 1987; 25(3):417-424.
3. Emmerich FG, Luengo CA. Metalurgia-ABM 1991; **47:**185-190.
4. Girelli CMA. *Propriedades de fricção de materiais naturais tratados termicamente*. 2001. MSc Dissertation. Universidade Federal do Espírito Santo, Brazil.

Acknowledgments

This work was partially supported by Capes and CNPq.

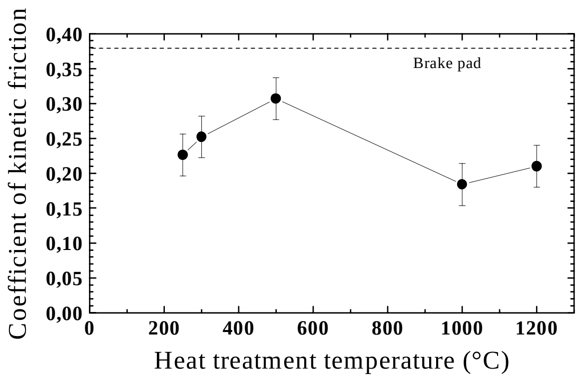

Figure 1. Coefficient of kinetic friction as a function of HTT.

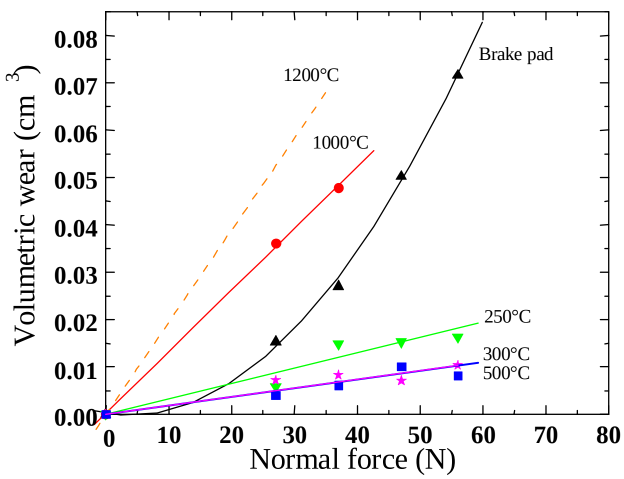

Figure 2. Volumetric wear as a function of the normal force applied.

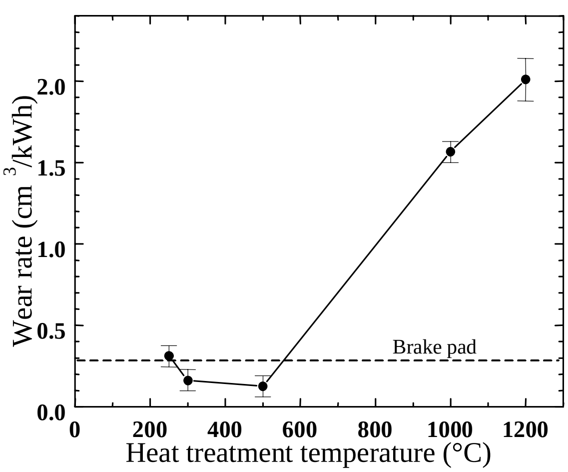

Figure 3. Wear rate as a function of HTT.

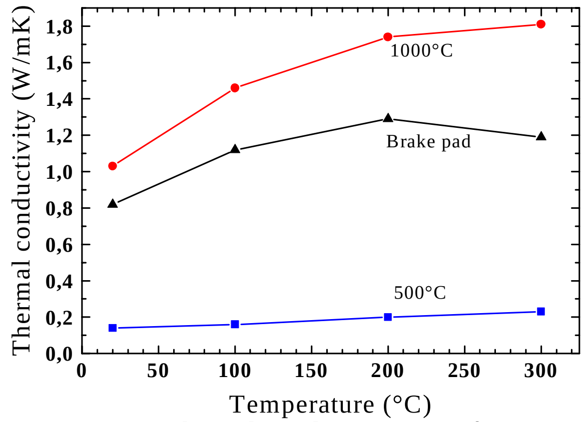

Figure 4. Thermal conductivity as a function of temperature.

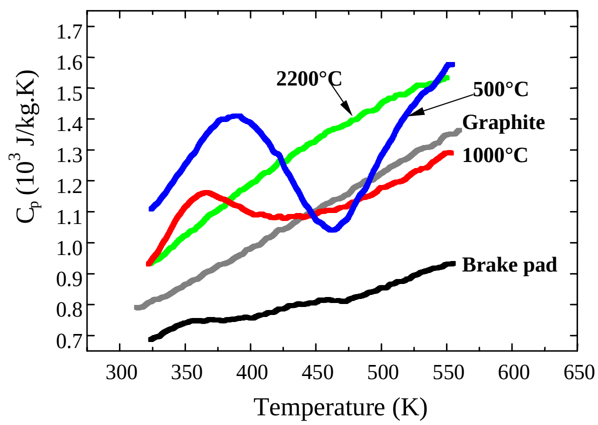

Figure 5. Specific heat as a function of temperature. The sample of 2200°C and the graphite are shown only for comparison.