Evaluation of Friction Phenomena for Brake Pad by Acoustic Emission Method

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Brake pads are composite materials made from dozens of ingredients intended to simultaneously satisfy various performances such as brake effectiveness, wear and NV. For this reason, the friction phenomena that occur during braking are complicated. This also makes it difficult to clarify the relationship between the ingredients and brake performances. In the meantime, regulations on the use of raw materials (such as Cu) are being strengthened, because those materials exert bad influences on the environment and health. Therefore, the search for alternative materials is necessary. Given this information, it is important to clarify the friction phenomena, but that is not easy because the friction phenomena are complicated as mentioned above.

We looked to acoustic emission (AE) as real-time evaluation method of friction phenomena. AE is a non-destructive testing method that measures elastic stress waves caused by the deformation and fracture of materials. Information like microscopic friction and wear phenomena that cannot be detected by changes in frictional force and vibration acceleration, can be detected by the AE method. In fact, it has been reported that the difference between abrasive wear and adhesive wear of metal can be identified from the change in the frequency spectrum of AE signals. But, not a single reported case has been applied to brake pads as far as authors know.

In this study, we verify whether differences in friction phenomena detected by the AE method. Three kinds of brake pads were used in the experiments. One of the specimens included an abrasive ingredient, one included an adhesive ingredient, and another included neither. AE signals were measured by an AE sensor attached to the back of specimens. The signals were analyzed by Fast Fourier Transform. In addition, frictional surfaces and wear debris were examined under microscope to clarify friction phenomena.

Measurements of the AE signals from the abrasive pad revealed harmonic signals. From the characteristics of the frictional surfaces and wear debris, it is thought that the AE signals were caused by the detachment of the tribofilm. On the other hand, about 600 kHz signals were detected in the adhesive pad. It is thought that those signals were caused by adhesive wear. This study showed that detachment of the tribofilm and adhesive wear can be detected by the AE method. The AE method can be used to evaluate the friction phenomenon of brake pads.