EXPERIMENTAL MEASURENENT OF STRAIN DISTRIBUTION IN SILICONE RUBBER BULK DURING FRICTION AGAINST A STAINLESS-STEEL SPHERE

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ABSTRACT
Friction control technology for the rubber that makes up the tire tread is extremely important for improving the braking performance of automobiles. When the vehicle is moving, the rubber tread comes into contact with asperities on asphalt road surface and is subjected to friction. In general, the friction force is explained as the sum of an adhesion term and a hysteresis term, but the hysteresis term contributes significantly to the friction force because rubber is a viscoelastic material. In order to establish friction control technology for rubber, it is necessary to understand the strain behavior inside the rubber, however experimental visualization of strain distribution inside the rubber during friction has not been achieved. In this study, to clarify the spatio-temporal strain distribution inside rubber during friction, friction tests were conducted on a silicone rubber (38 mm × 87 mm × 10.0 mm) and a stainless-steel ball (ϕ = 16.0 mm) at the normal load = 9.81 N, the sliding velocity = 20.0 mm, and the sliding distance d = 20.0 mm. The strain distribution inside the rubber was calculated using DICM [1] by observing the white powder distribution inside rubber through the transparent rubber layer (Fig. 1). Intending to measure the strain distribution at various vertical levels, the depth D of white powder was changed between 0.231–7.80 mm.

Fig. 2 shows the distribution of subset position, major principal strain ε_1, and minor principal strain ε_1 at d = 0.0, 0.7, and 10.0 mm and D = 1.48 mm. Red and blue vectors indicate tensile and compression, respectively. As d increased, it is experimentally confirmed that the in-plane distribution of subset position ε_1, and ε_2 got asymmetry, which would determine the hysteresis term. The results indicate that friction behavior of rubber would be improved by designing not only the vertical strain distribution but also in-plane strain distribution inside the rubber.

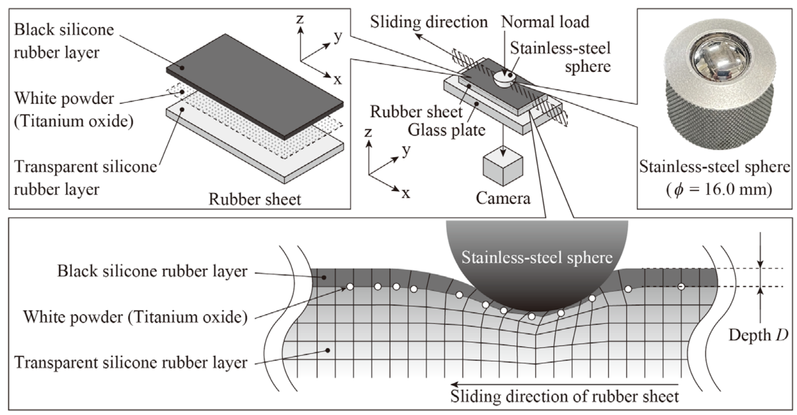

Fig. 1 Schematic of rubber sheet specimen and friction tests

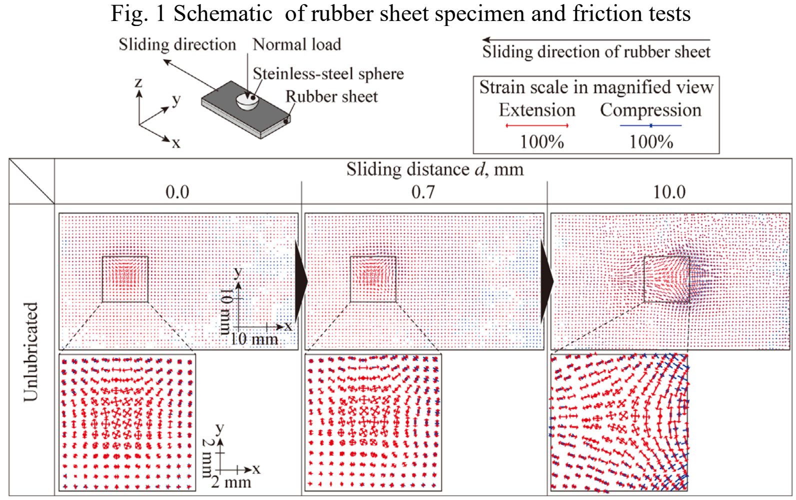

Fig. 2 Subset position and vectors of major and minor principal strains inside rubber bulk during friction against steel sphere at d = 0.0, 0.7, and 10.0 mm and D = 1.48 mm

REFERENCE
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