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ON THE WALL SLIP OF MAGNETORHEOLOGICAL ELASTOMERS IN ROTATIONAL PARALLEL PLATE RHEOMETRY

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Summary: The mechanical properties of magnetorheological elastomers can be altered in a rapid, continuous and reversible manner by the application of a magnetic field [1] which has been extensively studied in the last few years. Focusing on the magneto-coupled nonlinear viscoelastic behavior, and in particular on the particle structure evolution at large excitation amplitudes, dynamic oscillatory strain sweep experiments are performed for instance by means of double lab shear experiments or rotational parallel plate rheometry. Magnetic flux densities up to 1 T are applied perpendicular to the shear direction to this end. Maxima in the loss modulus and a decrease in the storage modulus found in magneto-coupled rotational parallel plate rheometry are frequently interpreted as structural rearrangements and interactions of the magnetizable particles. However, it has not been established whether slip mechanisms (adhesive failure at the sample-plate interface) are present and, therefore, interfere with the postulated changes in the particle network.

A systematic study is presented in order to reveal possible wall slip on elastomeric specimen. To exclude effects which could be attributed to fillers an unfilled model silicone rubber is used. Cylindrical samples (diameter of 20 mm and 1 mm thickness) are prepared by casting (two part mold) using a standardized methodology and characterized by means of a stress controlled rotational parallel plate rheometer (MCR 502/MRD 170/1T, Anton Paar). Studies include the determination of the influence of various normal force loadings and the influence of the plate surface, conducted using both a smooth and a serrated rotor. Material properties like crosslinking density and stiffness are also taken into account. The experiments suggest that wall slip will occur in any configuration if the deformation is sufficiently large and no cohesive failure occurs. No-slip conditions could be established only if the samples are cured in situ and are, therefore, strongly bonded to the apparatus. In conclusion it has to be stated that data in the literature may be misleading as a result of the misinterpretation of wall slip as structural changes.

References

[1] Jolly, M.R. et al. (1996), Smart Materials and Structures, 5, 607.