Ninth Semi-Annual Report for the Period Ended 31 October 1965

on the Program "Viscoelastic Behavior of Polymers at Long Times"

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Significant progress was made during the past grant period toward one of the major goals of our program of investigation; an elucidation of the pattern of viscoelastic behavior of crosslinked polymers as related to molecular structure. Our current study of natural rubber vulcanizates with different crosslink densities was completed by checking many of our earlier results and extending our temperature range of measurement. With our magnetic suspension torsional creep apparatus we were able to add the temperature range 1° to -50°C. These results enabled us to relate the region of rubbery response to the primary softening transition. The sum total of our results on the natural rubber system led us to propose a reduction procedure which resulted in a compliance curve which appears to have a character of universal applicability to crosslinked elastomers. This curve should have practical application in the prediction of equilibrium mechanical response in various rubbers.

In addition, measurements were continued on the polyvinyl acetate, PVAc, and polymethylmethacrylate, PMMA. To clear up the discrepancy concerning the position of the PVAc response on the time scale we obtained one of the samples from Professor John D. Ferry, University of Wisconsin, whose response has been reported in the literature. Our samples had responded about four times more slowly and after purification the Ferry-Ninomiya sample response agreed with our earlier measurements indicating that the literature values referred to above correspond to samples that

contain moisture absorbed from the air. Although this point is of trivial fundamental interest from a practical point of view, it can be significant. The fact that small amounts of diluent can change the glass temperature, T_g, is not new, but an appreciation of the effect on the mechanical response is not widespread. Loss of plasticizer, especially when initially present in small amounts as absorbed moisture is, can shift the time scale of response of polymers near and below their T_g many fold. Under vacuum conditions, as experienced in space, therefore, polymers in use near their transitions can experience large changes in mechanical properties.

Manuscripts finished.

A paper entitled "Effect of Crosslink Density on the Creep Behavior of Natural Rubber Vulcanizates" has been completed and is being submitted for publication. Twenty-five copies will follow this status report to the NASA Office of Research Grants & Contracts under separate cover.

A note on the "Crystallization Kinetics of 1,3,5-Tri-α-Naphthyl Benzene co-authored with Dr. Joseph H. Magill has been submitted for publication. Copies to NASA will follow.

Manuscripts in preparation.

The two papers covering all of the measurements of viscosity, viscoelastic response, and crystal growth rate on Tri-α-Naphthyl Benzene are expected to be completed shortly.

Upon completion of the above the descriptive paper on the magnetic suspension torsional creep instrument, which was started some time ago, will be resumed.

A note describing our convenient pulse producer, which yields electrical pulses at equally spaced logarithmic intervals, is being written.

Presentations.

The paper on the rubber vulcanizates mentioned above was presented on October 27, 1965, at the 36th Annual Meeting of the Society of Rheology which was held at Case Institute of Technology in Cleveland, Ohio.

Donald J. Plazek

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