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Experimental Investigation of Mechanical and Optical Characterization for Photo-Viscoelasticity

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The industrial use of viscoelastic materials have become recently remarkable, such as various types of rubber and asphalt pavement. In particular, the solid fuels of aerospace rocket behave a fairly nice viscoelastic character. Many investigators have come to awake the imoportance of stress and/or strain analysis, relating to their fracture and rigidity. However, it seems difficult or troublesome comparatively to analyse mathematically stress and/or strain with respects to complicated shapes or time dependent load conditions. As the situation of the photo elastic technique to mathematical elasticity, the photo-viscoelasticity may be utilized as a great useful tool of experimental stress analysis of viscoelasticity, though the latter exhibits a strong time and temperature dependence regarding mechanical behavior as well as optical one, birefringence. For the time dependence, assuming linearviscoelasticity and applying the correspondence rule originally proposed by Alfrey, the stress, strain and birefringence relation indicates the pseudo-elastic property on the Laplace transformed plane, and the analysis becomes very easy. There is a interdependence between the time and temperature, which reflects quantitatively the observation that behaviour at high temperatures and high strain rates is similar to that at low temperatures and low strain rates. Using this time-temperature relation, one can therefore deal simply in terms of a reduced time independent of temperature.

In present experiment, the stress and birefringence out put for polyurethane, rubber like material at room temperature, that exhibits viscoelastic behaviour, was measured by constant strain rate testing at various constant temperatures. From experimental data, author obtained the stress-strain and the stress, strainbirefringence relation for the analysis of photoviscoelastic problems.

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