

IMPORTANCE OF MASTICATION FOR POLYISOPRENE RUBBER

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Viscosity, elasticity and many dynamic-mechanical properties of elastomers can be affected by ageing. Some degradation might be irreversible, but even more evident transformations might take place due to migration, crystallization, rearrangement and similar transient mechanisms. In this study synthetic cis-1,4-polyisoprene rubber (p-isoprene) without added components was selected to observe ageing effects on a simple elastomer. Storage modulus G' was monitored after masticating the elastomer and storing it up to 8 days at room temperature. Long polymer chains can experience shear forces during mastication, but mechanochemical damage remains minor [1]. Mastication should homogenize lamellae, crystals and similar macromolecular agglomerates within the elastomer without much chemical degradation.

Bulk p-isoprene was sliced into small slabs of ~30 g and masticated on the two-roll mill HTR-300 (Hartek, China) for 25 passes at 22°C. Rolls of 360 mm OD were compressed to near-minimal nip size of 0.8 mm ± 30% and their velocity was set at 8 rpm with 1:1.25 sliding ratio. Specimens of p-isoprene were shaped into discs of 35 mm OD and 5 mm thick, weighing ~5 g, and were stored in dark cabinet. After ageing, the discs were placed in between disposable polymer sheets of 23 μm thickness and tested in a moving-die rheometer D-MDR 3000 (Montech, Germany) with biconical dies per ASTM D6204. Frequency sweep was used to record G' from 0.01 Hz to 50 Hz with 0.5% strain rate, 0.3 MPa interfacial pressure and 5 min hold time for each frequency value. After the first frequency sweep at 25°C each disc was heated to 50°C and the same measurement repeated without releasing the compression, Fig. 1.

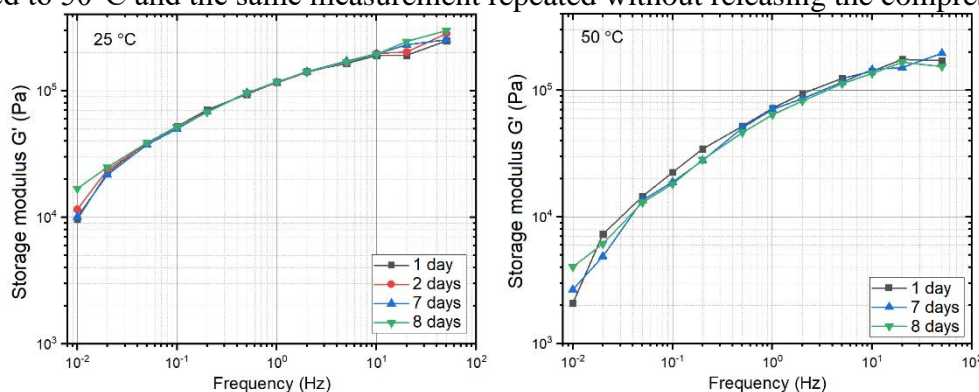


Fig. 1 Effects of mild ageing at room temperature on viscoelasticity of p-isoprene

The impact of ageing on storage modulus was not detectable at 25°C, but some drop of storage modulus G' at 50°C can already be observed. The magnitude is not large and might be considered negligible in some cases. Nevertheless, just 1 week at room temperature appears to lead to detectable changes in a relatively simple polymer like p-isoprene. Elastomer formulations with fillers, plasticizers, vulcanization additives and other functional additives are very likely to undergo much more rapid and significant transformations. Evidently, mastication is very important in testing elastomer formulations and should be widely enforced.

References

1. C. Wortmann, P. Lindner, F. Dettmer, F. Steiner, T. Scheper. Journal of applied polymer science. **131** (2014) 39989.