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THE VIBRO-ACOUSTIC PROPERTIES OF EPOXIDISED NATURAL RUBBER (ENR)

INTRODUCTION

- Three types of rubber with different epoxidation levels: 0, 25 and 50 mol % were investigated.
- The dynamic properties of these materials were measured at different temperatures and frequencies.
- The measured dynamic properties were superposed to form master curves using time temperature superposition equivalence, thereby the dynamic properties for each rubber can be seen in a broader frequency and temperature range.
- These data are essential for modelling the vibro-acoustic behaviour of ENR in a range of noise control applications.
- These types of rubber are now being developed into porous media using a novel production process.

METHOD

- Rubber formulations:

Ingredient	R0	R25	R50
Rubber	100		
Sulfur	2.5		
Antioxidant	1		
Zinc Oxide	4		
Stearic Acid	4		
CBS	1		
PVI	0.3		

- Dynamic properties were tested using Metravib DMA +1000 machine.

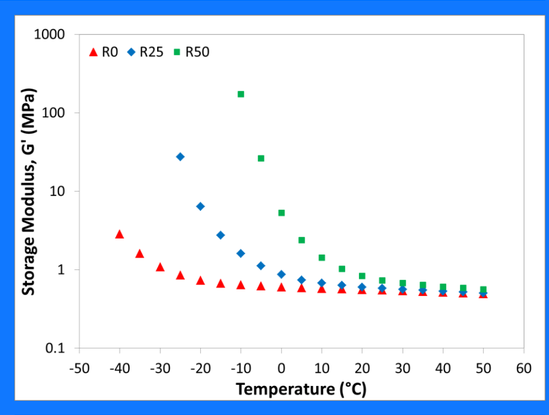
- Test conditions:
  - Shear Mode
  - Frequency: 1-170 Hz
  - Temperature: -40°C to 50°C
  - Strain: 1%

- Application of time-temperature superposition principle:
  - Horizontal Shifting, a_T
  - Vertical Shifting, b_T

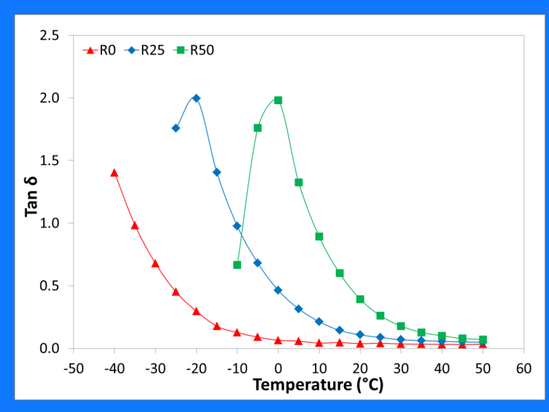
$$\log a_T = -\frac{C_1(T - T_0)}{C_2 + T - T_0} \qquad b_T = \frac{\rho_0 T_0}{\rho T}$$

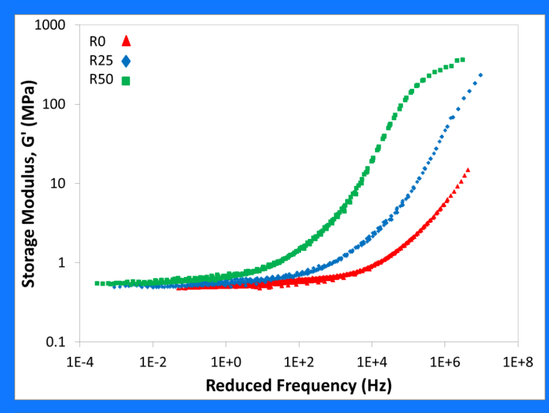
RESULTS

- **Effect of Temperature:**
  - Storage modulus, G' and Tan δ are parameters used to identify the stiffness & the damping of rubber.
  - The variation dynamic properties at 10 Hz excitation for natural rubber are identified.



- **Effect of Frequency:**
  - Dynamic properties are predicted at a broader frequency range by obtaining a master curve using time-temperature superposition principle.
  - The master curve represents the dynamic properties at reference temperature of 20°C in a broader frequency range from 0.01 Hz to 10,000,000 Hz.



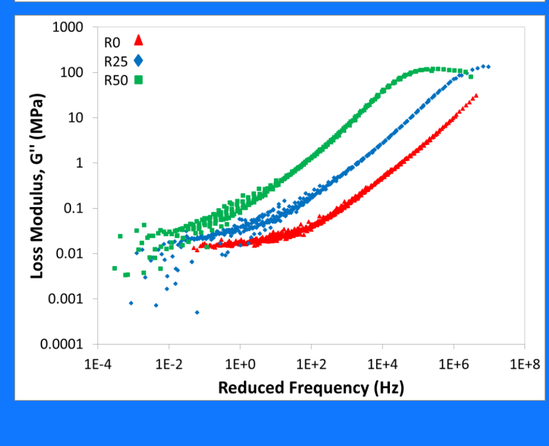


- **ENR Foams Manufacturing:**

ENR foams

Microscopy image

Density < 300kg/m^3



CONCLUSION

- The damping of rubber plays a key role in noise control applications. Such damping is needed to reduce structure-borne vibrations and their ability to generate air-borne noise.
- The results obtained are useful to understand the dynamic properties of natural rubber at a range of temperatures and frequencies. These are essential to predict if natural rubber can perform well in noise control application where the environmental conditions and excitation are changing.

C_1 & C_2: viscoelastic coefficients; T: selected temperature; T_0: reference temperature; ρ_0: rubber density at reference temperature; ρ: rubber density at selected temperature