Viscoelastic Properties of O-Rings

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Five different kinds of o-rings were purchased from (McMaster-Carr, USA); sample information is summarized in Table 1. Complex modulus was measured with the iNano indentation system (Nanomechanics, Inc., Oak Ridge, TN) using a flat-ended cylindrical punch (D=100μm). All the tests were conducted at room temperature using the test method "Dynamic Flat Punch Complex Modulus." After pressing the punch face into full contact, the iNano measured storage and loss modulus (E' and E") at frequencies from 1 to 200 Hz.

Table 1. O-ring sample information

ID	Product Name	Storage Modulus at 35Hz (MPa)	Loss Modulus at 35Hz (MPa)	Loss factor at 35Hz
1	Oil-Resistant Buna-N Multipurpose O-Ring Size 210	34.40±0.93	6.11±0.13	0.18±0.001
2	Super-Resilient High-Temperature Silicon Ring	18.53±0.55	1.16±0.04	0.06±0.001
3	Chemical-Resistant Multipurpose O-Ring	14.93±0.65	7.42±0.32	0.50±0.003
4	Steam-Resistant EPDM O-Ring	47.33±0.68	6.06±0.07	0.13±0.003
5	Oil-Resistant Buna-N Multipurpose O-Ring Size 202	27.96±0.62	5.38±0.07	0.19±0.003

Instrument indentation technique is capable of measure the same results as conventional DMA, but offers localized measurement with faster and easier data collection. Figures 1 and 2 show the storage modulus (elasticity) and loss modulus (damping), respectively, as a function of frequency. The mechanical behavior varied significantly from sample to sample, and should be considered when deciding which kind of o-ring is best suited for a particular application. The properties of the silicon o-ring (sample 2) were substantially independent of frequency. By contrast, the properties of the other o-rings depended quite strongly on frequency, with sample 3 manifesting the greatest frequency dependence.

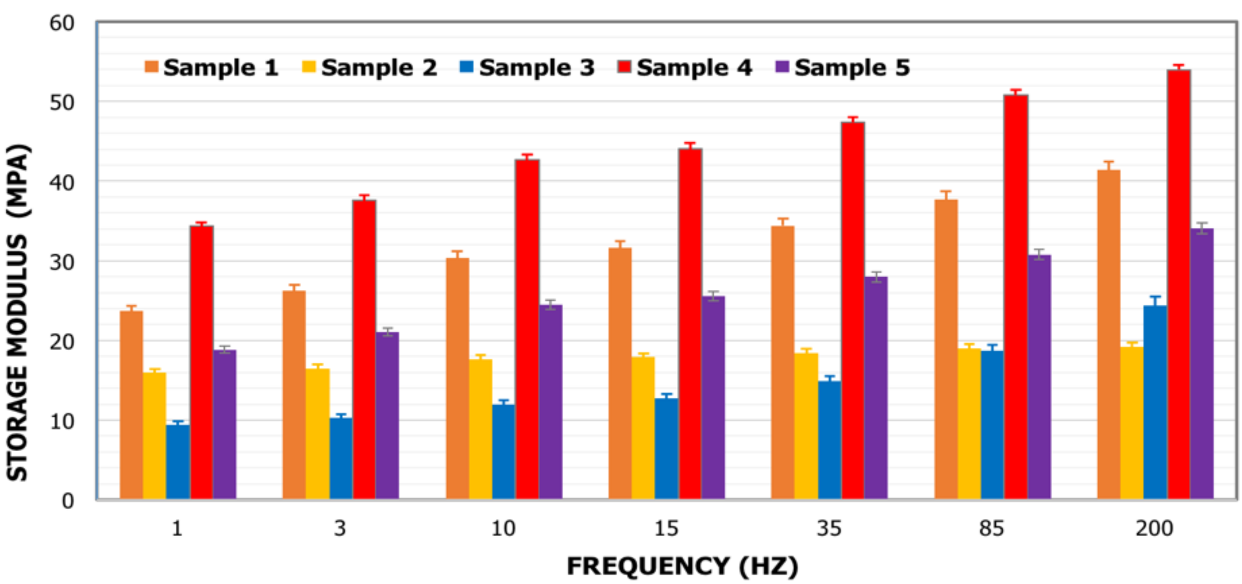

Figure 1. Storage modulus of o-ring samples as measured by oscillatory indentation

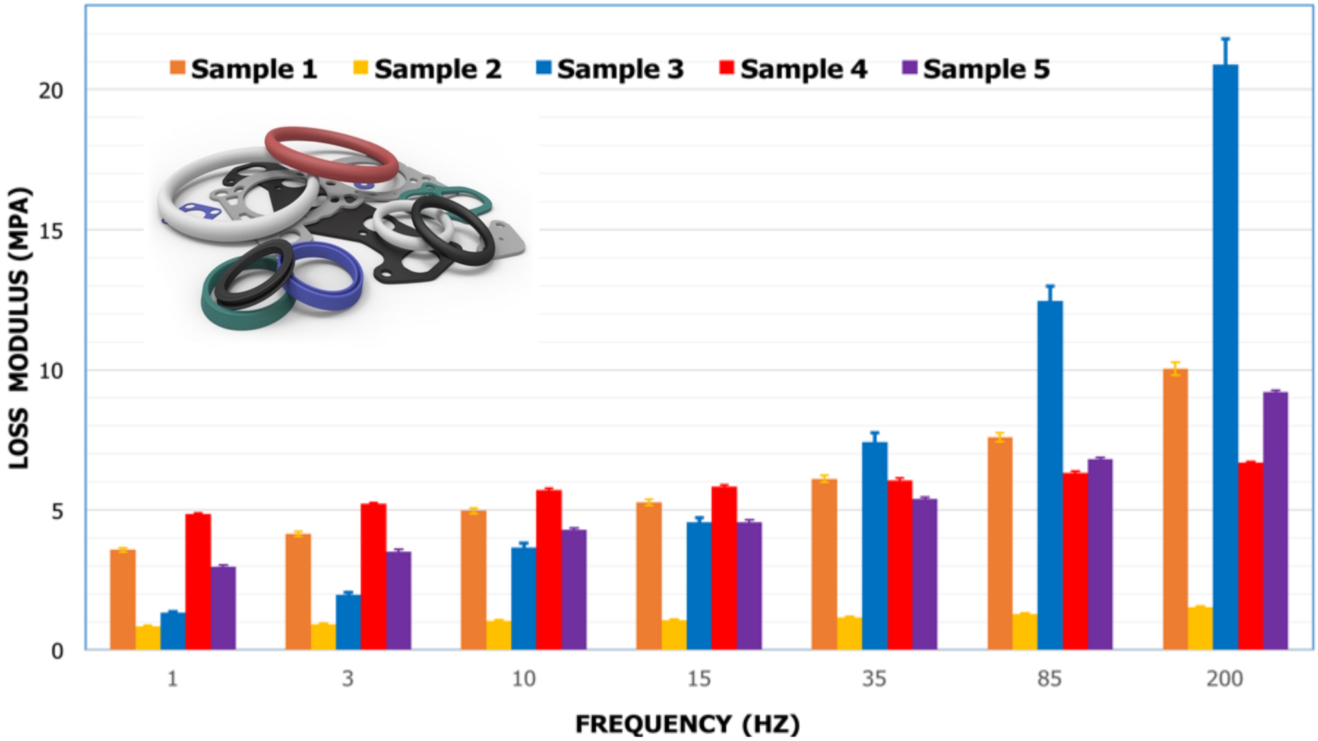

Figure 2. Loss modulus of o-ring samples as measured by oscillatory indentation