Compressive Modulus of Elasticity for Gap Pad® Materials

An important characteristic of a gap filling product is its ability to deflect at low pressures. This property is reflected in compressive modulus (Young's Modulus) and compression deflection data. Modulus is a measure of the hardness or softness of a material and is equal to stress divided by strain. Stress is equal to pressure. Strain or deflection is equal to the ratio of the change in thickness to the original thickness of the material. The lower the modulus the softer the material. In most cases, a soft gap filling material is desired to minimize the pressure exerted on printed circuit boards, component leads, and solder joints while the material is being deflected during the assembly process.

Variability in Compressive Modulus values

Compressive modulus can be measured in various ways yielding different values for the same material, depending on the test method and test parameters specified. Compressive modulus can be measured by dynamic and non-dynamic methods. Dynamic or periodic methods measure the complex modulus, which is made up of the storage modulus and the loss modulus. Non-dynamic or transient methods measure the relaxation modulus. Among the transient methods are constant rate of strain and step application of strain methods.

Since Gap Pad is viscoelastic its modulus is time dependent. This means that the complex modulus varies with the frequency of strain and the relaxation modulus varies with the rate of strain. At high frequencies and rates of strain the complex modulus and relaxation modulus of Gap Pad will be higher and it will appear harder. At lower frequencies and rates of strain the complex modulus and relaxation modulus of Gap Pad will be lower and it will appear softer. Viscoelastic materials will stress relieve themselves over time, so increasing the measurement time interval in a step strain application test will decrease the modulus measured and the material will appear to be softer.

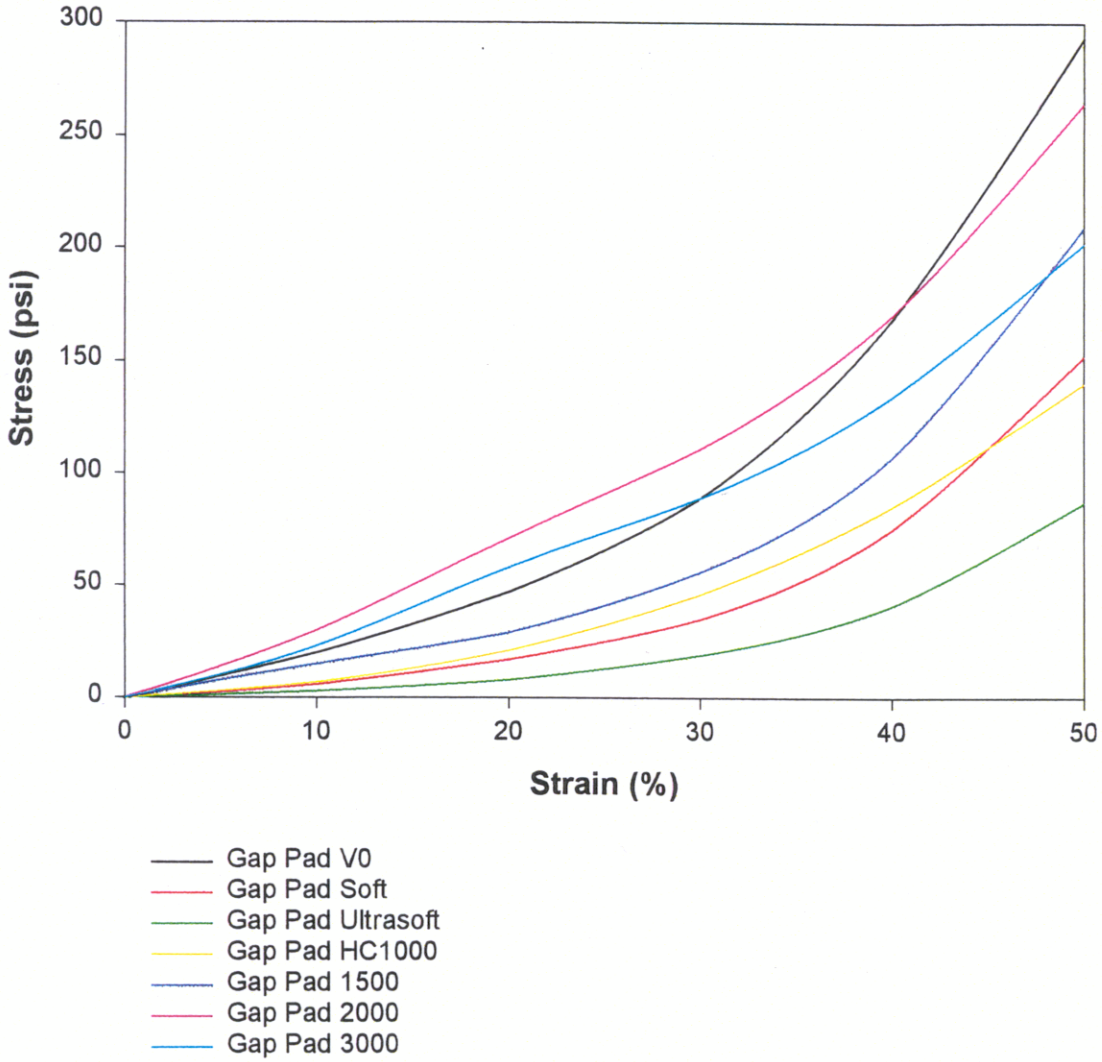
Constant Rate of Strain Relaxation Modulus

The constant rate of strain transient test involves applying an increasing strain at a constant rate while measuring the induced stress. This type of test simulates the deflection of a gap filling material during the course of an assembly process. A design engineer needs to know the constant rate of strain while the product is being assembled (see Graph #1). During the constant rate of strain transient test the measurement time interval is small and the amount of relaxation of the test material is low. Therefore, it will give the engineer an indication of the maximum stress that will be generated in the application. Here the design engineer needs to remember that by decreasing the rate at which the Gap Pad is deflected during the assembly process, the stress induced in the application can be decreased (see Graph #2)

Step Application of Strain Relaxation Modulus

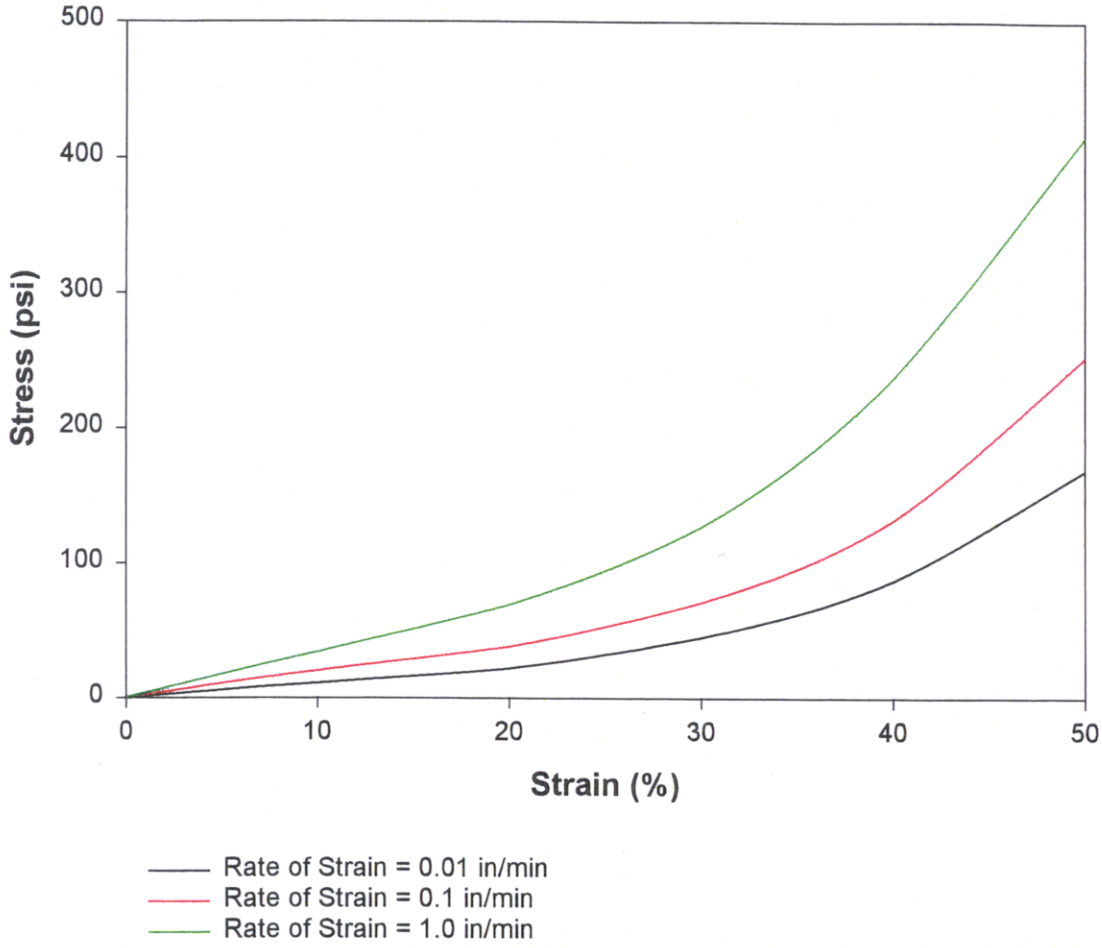
The step strain transient test involves an initial application of strain at a constant rate to a pre-determined level of strain and then measuring the decay of stress as a function of time. This is also known as a stress relaxation test. A design engineer will want to know the step strain relaxation modulus of a Gap Pad to determine the stress being exerted on pcbs, devices, solder joints, etc. over time as the material stress relieves itself from the assembly process (see Graph #3). Again, the design engineer needs to remember that by decreasing the rate at which the Gap Pad is deflected during the assembly process, the relaxed stress level can also be reduced (see Graph #4).

Compression Deflection
With Constant Rate of Strain
Graph #1



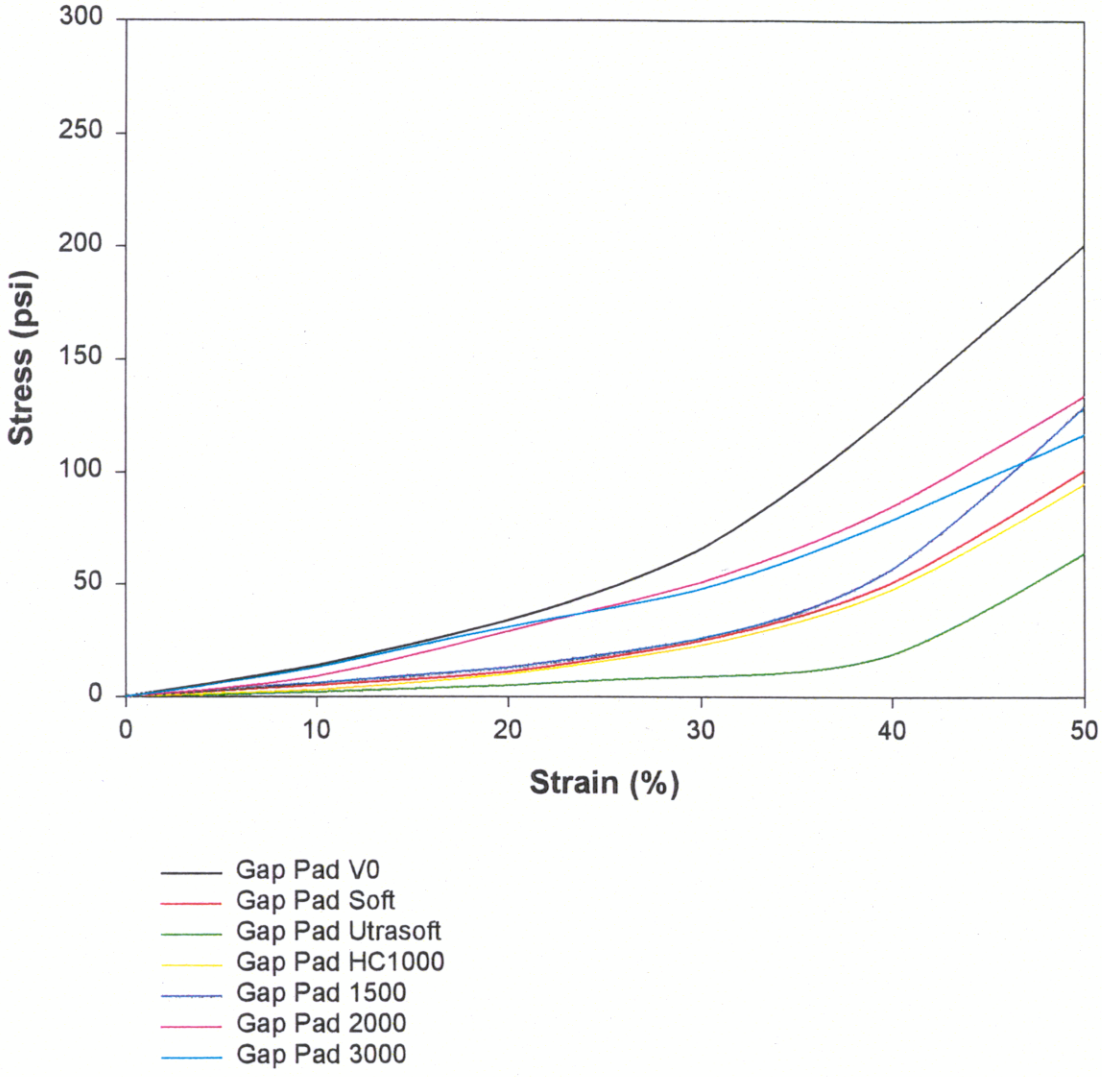
- All Gap Pads 125 mils thick.
- 1 inch diameter circular test samples.
- Rate of strain = 0.04 in/min.

Compression Deflection
With Constant Rate of Strain
Graph #2



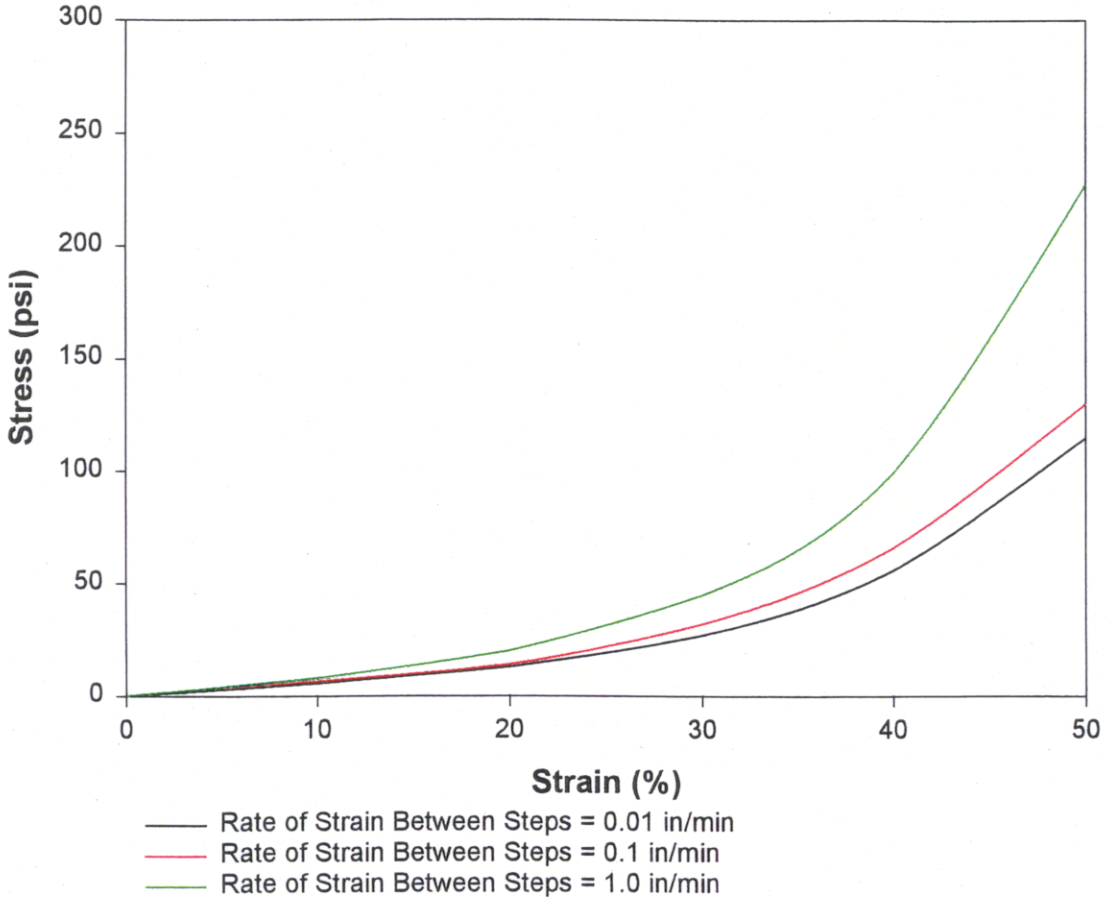
- GP1500 125 mils thick.
- 1 inch diameter circular test samples.

Compression Deflection
With Step Application of Strain
Graph #3



- All Gap Pads 125 mil thick.
- 1 inch diameter circular test samples.
- Rate of strain = 0.04 in/min between each step application of strain.
- Stress measurement time interval of 2 minutes for each step application of strain.

Compression Deflection
With Step Application of Strain
Graph #4



- GP1500 125 mils thick.
- 1 inch diameter circular test samples.
- Stress measurement time interval of 2 minutes for each step application of strain.

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