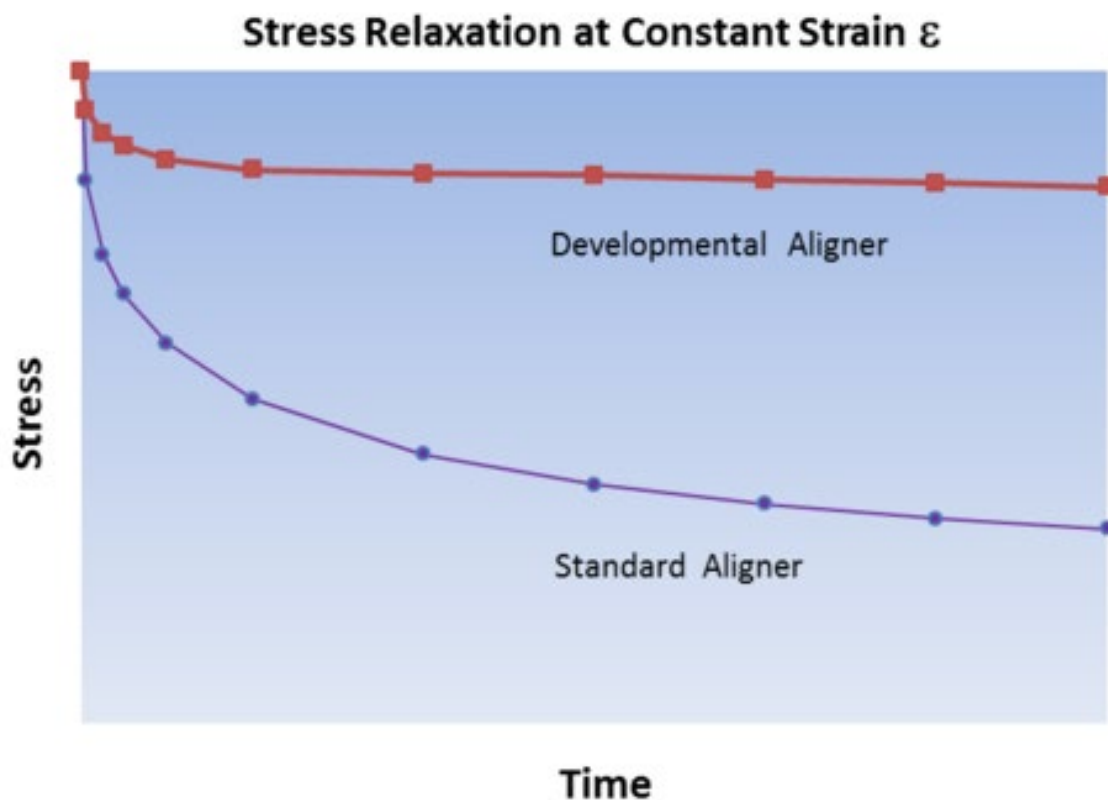


STRESS RELAXATION IN ORTHODONTIC APPLIANCES

WHAT'S STRESS RELAXATION

In everyday life, “stress relaxation” describes what happens after a long, hard day’s work when you take your shoes off and rub your toes to relax your feet. In the material science world, when we're talking about the material property “stress relaxation,” it describes **how a material behaves when subjected to prolonged constant strain over a period of time**. In other words, if you press (or pull) on a material long enough and hard enough, what happens to it? Does it slowly give way? Crack? Warp? A change like bending, cracking or creeping is the material's way of releasing stress.

Stress relaxation test data is often presented in the form of a stress versus time plot graph (see example below).



If the stress in the material remains high, it is resisting the load applied to it. If the material is warping or bending in response to the applied strain, its stress will drop.

Why Is Stress Relaxation Important in an Orthodontic Appliance?

Low stress relaxation is an important performance property. An aligner's job is to apply specific stress to teeth that guides them into a new position over time. This means the teeth are applying strain right back to the aligner! So, an aligner with lower stress relaxation will better ensure that it is the teeth that move, rather than the aligner material deforming.

When an aligner applies force to a patient's teeth, it is typically loaded (or stressed) to a pre-determined stress-strain level. From the moment the aligner starts to move the teeth, at the same time it is slowly losing some of the applied stress (or it is "relaxing"). Gradually, the aligner loses its ability to apply the force necessary to continue moving teeth, requiring replacing the aligner with a fresh one.

So, it is important to know the stress relaxation properties of the available thermoplastics to be able to design aligners capable of moving teeth a prescribed distance in a given period of time.



Stress Relaxation Is Only One of the Key Properties

Although stress relaxation is an important performance factor for an aligner material, other key properties include crack resistance and toughness (impact strength), chemical resistance (to staining agents), and optical transmission (clarity).

Developing a material that achieves the optimum balance of all these key properties is not trivial and requires deep material science expertise and years of R&D work.

How We Test Stress Relaxation

We evaluate the characteristics and performance of our Zendura materials using recognized test methods such as the American Standard Test Methods (ASTM).

Since aligners are worn inside a patient's mouth for long periods of time each day, we test the stress relaxation property in controlled environments, such as constant temperature 37C, and in 95-100% relative humidity (RH), for pre-determined time periods, around 24 hours. Testing in 100% RH is identified with a part fully immersed in water.

We perform stress relaxation tests under various strain levels, typically in the range 1-5%. Results from such accelerated or harsh tests are then used to make inferences to thermoformed aligners' performance properties. This controlled accelerated testing is common and acceptable practice in polymers and in various applications.

A graphical representation of stress relaxation at constant strain "e" is displayed in the graph shown earlier.

At Bay Materials, new and advanced materials or processes are typically subjected to such rigorous tests for accurate determination of any observed performance benefits over existing products or processes.

Our Charter Is Developing New & Innovative Thermoplastic Materials to Advance Clear Aligner Therapy

Our team of material scientists at Bay Materials have dedicated their efforts to the development of advanced orthodontic thermoplastic materials for over two decades. The materials we developed nearly two decades ago made possible what today is a multibillion-dollar clear aligner therapy industry. We have earned a reputation in the global orthodontic community for being the leading provider of advanced material solutions.

See also [Crack and Stain Resistance Properties](#).