Thin Film Gripping and Jaw Face Comparison

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Introduction

Thin films are most notably used to manufacture packaging for consumer goods, but their versatility makes them more common than some might expect. These materials can also be found in electronics, batteries, optical coatings, material backings, and other products. To ensure that thin films being manufactured meet the required expectations, companies must obtain an accurate mechanical profile of their products. The most common standards followed for testing thin films are ASTM Standard D882 and ISO Standard 527-3, including test procedures specific for TYE (Tensile Strength, Yield, and Elongation) and for Modulus.

Unlike many plastic and elastomer specimens, thin film specimens are not cut into 'dogbone' shapes but instead cut into rectangular shapes of uniform thickness and width. The absence of a reduced section within a testing gauge length - combined with the fragile nature of thin film specimens and their tendency to experience a dramatic decrease in cross-sectional area during testing - can often lead to difficulties when testing. The purpose of this guide is to provide a general overview of what is expected when testing thin film specimens of various thicknesses with different gripping and jaw face combinations.

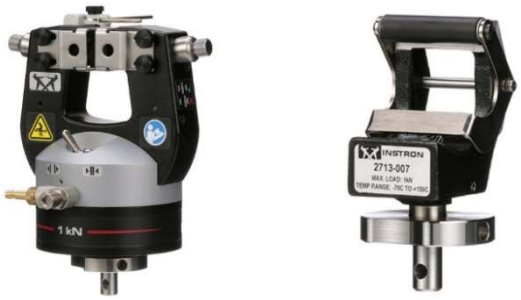

Figure 1 - Pneumatic side action grips (left) and roller grips (right)

Pneumatic Side Action Grips for Thin Films

Pneumatic side action grips offer a versatile gripping solution for a wide range of materials. The gripping force is controlled by adjusting the inlet air pressure and remains constant even if the specimen thickness changes significantly during testing. With the combination of consistent gripping pressure and Instron's patented quick-change jaw faces, pneumatic side action grips have been established as the premium gripping solution for thin film testing. Because thin film specimens are prone to extreme thinning during testing, the consistent clamping pressure sets pneumatic side-action grips apart from other grips and leads to the highest repeatability of any gripping solution for these materials.

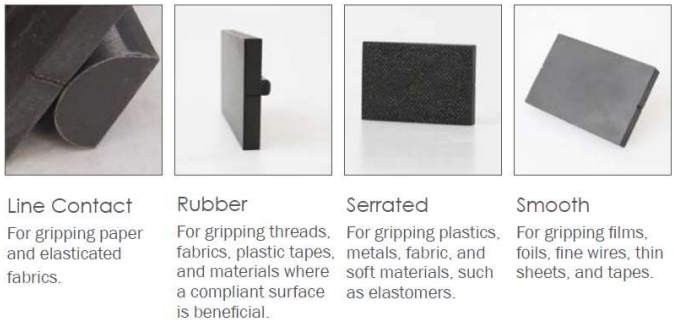

Figure 2 - Pneumatic side action grip jaw faces for thin film testing

Smooth jaw faces are highly versatile and are a common choice for testing thin film specimens. Smooth faces have a hard-enough surface to allow minor extrusion without allowing any slippage or damage to the specimen. Due to the wide range of specimens compatible with smooth jaw faces, these are usually the preferred solution for most standard thin film specimens.

Line contact jaw faces are another top choice for thin film materials. Line contact faces include one smooth jaw face and an opposite face that is rounded, helping to distribute the clamping force along a single line perpendicular to the crosshead's movement. By reducing the area of contact between the faces and the specimen, line contact faces not only have the best chance to prevent slippage, but they also prevent the specimen from extruding out during testing. In cases where no specimen extrusion is allowed, these jaw faces offer the most appropriate solution. However, it should be noted that due to the high stress concentration along the line of contact, fragile specimens are more likely to experience premature jaw breaks.

Rubber jaw faces are another useful option for testing thin film materials, but they are generally considered to be a secondary option. One concern with using rubber faces is that they allow the greatest amount of jaw face extrusion. This can be good when extrusion of the specimen is acceptable, or when testing is meant to replicate a real-life scenario. However, in cases where additional jaw face extrusion is undesirable, a better solution would be smooth or line contact faces. Another area of concern is that rubber jaw faces struggle to grip specimens on the smaller or larger end of thickness tolerances for most standards. Since rubber jaw faces are softer and more permeable than smooth jaw faces, they are more likely to allow smaller specimens to slip as the specimen thins out. Additionally, these softer faces can sometimes require a higher gripping pressure. For specimens that break close to the maximum capacity of the grips, rubber faces have a higher chance of providing inadequate clamping forces and may allow the specimen to slip out during the test.

Though serrated jaw faces are commonly used in testing many plastic and elastomeric specimens, they are often too aggressive for testing thin films. For most thin film specimens, serrated faces are likely to cause premature jaw breaks during testing as the specimen thins out over the serrations. There are some cases, however, when serrated faces can be a viable solution when other available jaw faces are unable to prevent slippage during testing. These cases commonly involve testing thicker materials with low elongation.

Roller Grips for Thin Films

Self-tightening roller grips such as Instron's 2713-007 grips can sometimes be used as a more basic solution for thin film testing. Self-tightening roller grips seem to work best with specimens that exhibit high elongation with lower than average maximum forces, but they can also sometimes work with various other thin film materials. The main challenge presented by roller grips is whether or not the thin film material is slippery in nature. When using a slippery specimen such as ultra-high molecular weight polyethylene, the specimens are highly likely to slip out during testing. These grips can be finished with either a rubber or smooth metal material, allowing them to test a reasonable variety of thin film materials.

Wedge Grips for Thin Films

The Instron® manual wedge action grips are designed for easy specimen loading, alignment, and positioning. After the initial face-to-specimen contact, the gripping force will increase as the testing load increases. These grips are designed to tighten on a specimen without altering the vertical position of the faces in relation to the specimen, thus keeping the initial gauge length constant.

Figure 3 - Close up wedge grip jaw faces

While wedge grips are adequate for testing most dog-bone specimens, they can present several issues when testing thin film specimens. One strength of wedge grips is their ability to increase gripping force on a specimen as the test load increases, but this strength becomes a weakness when testing thin films. Since the gripping force is directly dependent on the specimen pulling the jaw faces upwards as the load increases, it does not account for specimens that undergo excessive thinning during testing. While the wedge grips would also keep increasing their clamping force on the thinning specimen, the rate of thinning often becomes greater than the grip's ability to clamp it, resulting in slippage. Because of this, wedge grips are often seen as an inadequate solution for thin film testing.

Advanced Screw Side Action Grips for Thin Films

Advanced/manual screw side action grips resemble pneumatic side action grips in their clamping style, except that they need to be manually tightened on each specimen. The ability to manually clamp down very hard on a specimen may seem like it will prevent the specimen from slipping, but when a material begins thinning during testing, there is no way to maintain the initial gripping pressure. For this reason, manual screw side action grips are one of the most difficult solutions for thin film specimens. They are not recommended for testing thin films and should only be used on a case by case basis.