Dektak Stylus Capabilities
How to Choose the Correct Stylus for Any Application

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Dektak® stylus profilers provide accurate, high resolution measurement of surface shape and texture. The heart of a Dektak system is its measurement stylus, which runs over the surface as the sample is moved beneath it on the stage. A variety of stylus shapes and sizes are available to optimize measurement for particular applications. This paper describes the variety of styli that are currently available from Veeco, and guidelines for choosing the optimal tips for your application.

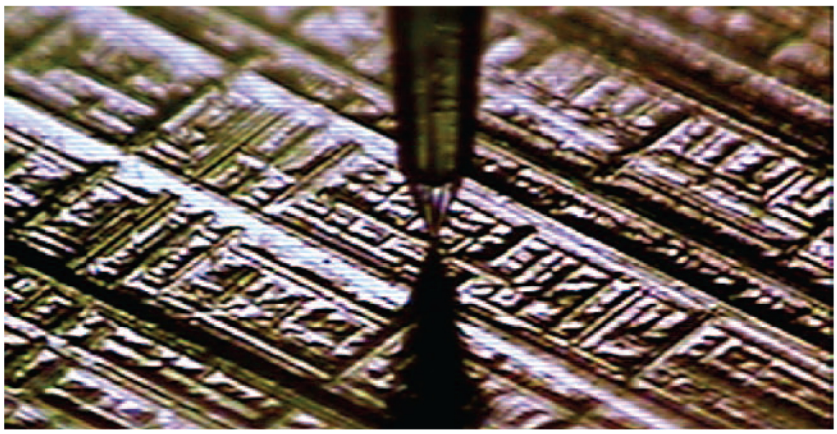


Figure 1. 0.2 micron radius stylus tip with a 45° cone angle.

Stylus Geometry

Dektak styli are either milled or etched from diamond stock to form measurement tips with particular geometries (Figure 1). The majority of tips terminate in a 45° cone with an end radius from 25 microns down to 0.2 microns. Other specialized tips include high aspect ratio and super sharp styli for measuring exceptionally small features and roughness.

Depending on the application, the shape of the tip may have a significant impact on the measurement data. In Figure 2, for example, the dimensions of a 200µm wide by 20µm deep trench are being verified. The depth and width of the trench could be measured with a large, sturdy 25µm radius stylus. As the width of the trench shrinks, however, the large tip can no longer accurately report the width. As the width shrinks further, the tip cannot reach the bottom of the trench to accurately gauge its depth. A high aspect ratio (HAR) or small diameter tip would serve better in the smaller trenches. Because Dektak tips have a 45 degree included angle, they are able to measure higher aspect ratio trenches than other manufacturers' 60 degree tips.

In the following section we will describe the primary features of each of the standard Dektak styli, including the applications for which each is best suited.

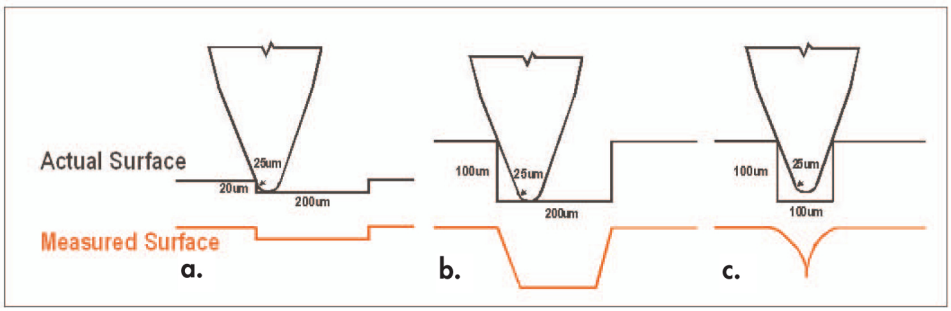
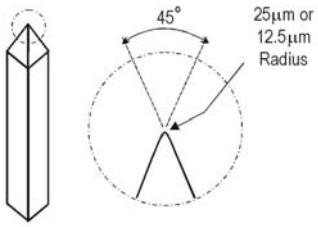


Figure 2. The geometry of the stylus must be considered for each application. This 25µm tip easily measures larger trenches (a), but cannot accurately measure the width (b) and height (c) as the trench aspect ratio increases.

Standard Tips

• 25µm and 12.5µm Tip



These large radius styli are exceptionally sturdy and durable, well-suited for general purpose step height, roughness and stress measurements. In the latter two cases, the large diameter helps the stylus to glide over finer details, effectively filtering out minute roughness to provide a more accurate view of the overall shape (Figure 3). Both styli are capable of measurement in trenches with an aspect ratio as large as 1:1.

Two types of each stylus are available. "B" type styli are general use tips that satisfy the requirements of most applications. "A" type styli are manufactured to tighter, certified specifications and include a scanning electron micrograph for verification.

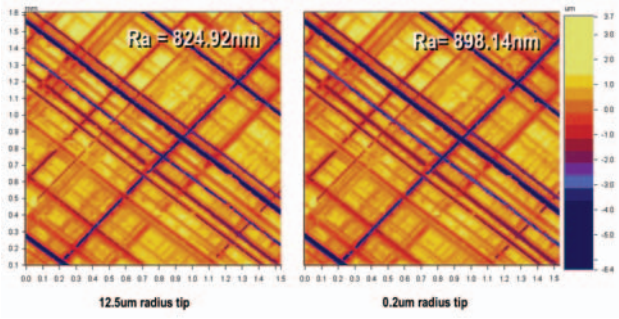
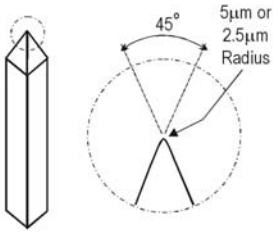


Figure 3. Comparison of roughness measurements made with 12.5µm and 0.2µm radius styli. The larger stylus "filters" out roughness, giving a better representation of shape. The smaller stylus provides more accurate roughness detail, thus the 8% larger Ra (average roughness) value.

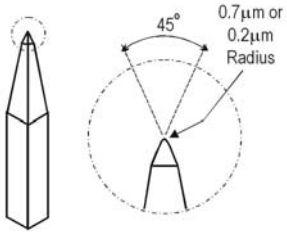
• 5µm and 2.5µm Tip



Medium-diameter styli are the workhorses of the industry. Both the 5µm and 2.5µm styli are sturdy enough for every day use while still providing ample resolution for roughness and small amplitude waviness measurements. Trenches with aspect ratios as large as 1.2:1 can be measured.

As with the larger styli, both "B" (general use) and "A" (SEM verified) types are available.

• 0.7µm and 0.2µm Tip



These sub-micron styli provide excellent resolution for roughness measurements (Figure 4), wall and trench characterization, and measurements in constrained areas. Veeco highly recommends that both styli are used with the N-Lite low force, low inertia sensor for scratch-free characterization of delicate samples such as gold or oxide films. Care should be taken to avoid damaging these delicate tips (see GUIDELINES section below).

Because of their refined shape, and the additional complexity of manufacturing, only "A" type sub-micron styli are available.

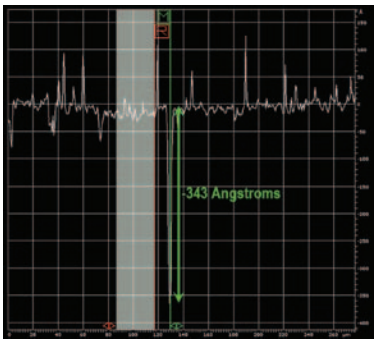
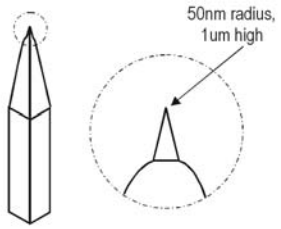


Figure 4. Without N-Lite, a sub-micron tip scratched this gold film. With N-Lite, the same tip measured the scratch without damaging the sample.

Super Sharp and High Aspect Ratio (HAR) Tips

• 50nm Super-Sharp Tip



To manufacture Veeco's exclusive 50nm radius stylus, the end of a larger diameter stylus is etched with a focused ion beam to form a sensitive, needle-like tip (Figure 5). The super-sharp stylus is ideal for high-resolution measurement of fine roughness. It is also the appropriate choice for measuring STI (shallow trench isolation) and other small features. The 50nm tip must be used with the N-Lite low force sensor to avoid damage to either the sample or the tip.

Only an "A" type version is available.

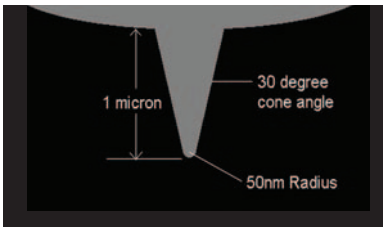
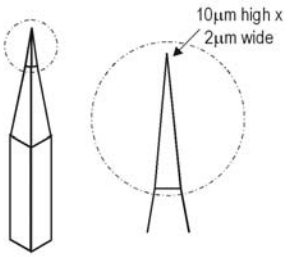
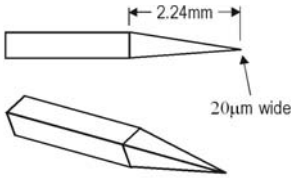


Figure 5. The super-sharp, 50nm-radius tip is the most sensitive—and delicate—of Veeco's stylus options.

• 2x10µm HAR Tip



• 20 x 200µm HAR Tip



The high aspect ratio (HAR) tips are designed to characterize the floors, walls and width of trenches with aspect ratios as high as 10:1. The names of these styli reflect the maximum trench height-to-width ratio that the tip can characterize. Using slower scan speeds, HAR tips can reach deep into the corners of trenches to accurately measure shape and wall angle.

Custom Tip Geometries

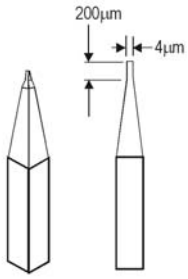


Figure 6. A custom "chisel-type" stylus was designed to locate and measure the highest point of each solder bump in an array.

From time to time an application arises which requires a different stylus geometry than those of the standard styli. In these cases, Veeco is able to work with customers to design and fabricate tips with specialized characteristics.

As an example, integrated circuit packagers required verification of the height and coplanarity of solder bumps to ensure proper mating between the chip and substrate. To accurately measure the height of a solder bump, the stylus must contact, and measure, the highest point on the bump. A chisel type stylus was created for this application. The broad side of the tip is scanned over each solder bump, ensuring that some portion of the tip will find the highest spot on the bump (Figure 6), even if the bumps are not aligned.

Guidelines for Proper Stylus Usage

Choosing the right stylus for an application is important, but maintaining that tip geometry over time is equally critical. Stylus wear or damage can quickly lead to inaccurate results and/or potential damage to the sample surface. To ensure long stylus life:

- Always verify that no features on the surface exceed the height of the stylus. Lateral contact between the stylus and sample is the primary cause of damage.
- Press the Unload button to raise the tower and move the stage to a safe position before removing the sample.
- Store styli in their protective cases when not installed on the system.
- When measuring taller features, use a slower scan speed to limit sudden forces on the stylus.
- Always use the N-Lite option with sub-micron tips to avoid damaging the sample surface.
- For each application use the lowest force and largest radius possible to ensure long stylus life.

Reference

1. ANSI B46.1 "Surface Texture (Surface Roughness Waviness and Lay)" 2002, published by the American Society of Mechanical Engineers.