Optical Profiling Provides 3D Measurement of Blades and Sharps

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Precision blades and cutting instruments are responsible for everything from a clean shave to a successful medical procedure. Careful quality control over surface finish and cutting angles is critical to blade performance in every one of these applications.

Optical profiling is a well-established method for accurate, repeatable and rapid 3D measurement of surface shape and roughness. The non-contact technique has been applied to research and production measurement of precision blades and many other medical-grade instruments. Figure 1, for example, shows a false-color surface height map (500μm^2) of an aluminum skin graft blade, as imaged with a Wyko® NT Series Optical Profiler. This application note discusses how optical profiling is used to measure and control key quality parameters in the production of consumer- and surgical-grade blades and sharps.

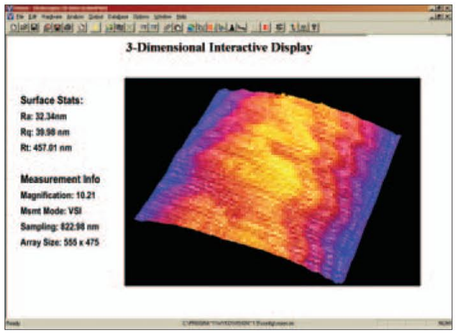


Figure 1. Optical profiler measurement of aluminum skin graft blade.

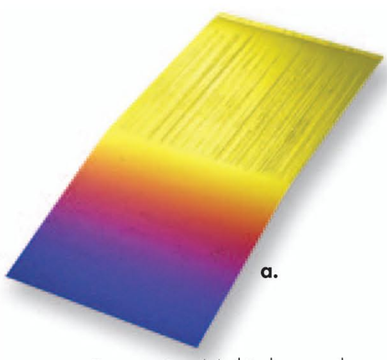
In the blade manufacturing process, incoming strip stock undergoes progressive heat treating operations to achieve the correct edge hardness and durability. Perforations are added, and one or more angles are ground in to produce the optimal cutting edges. The strip is then singulated into individual blades, after which diamond-like coating (DLC) or other films may be added to improve durability and reduce friction.

Blade comfort and cutting quality are highly dependent upon both surface finish and proper cutting angles, and optical profiling has been employed to measure both of these parameters. As shown in Figure 1, an optical profiler can obtain such standard surface finish parameters as average roughness (Ra) and peak-to-valley height (Rt). Since optical profiling is a true 3D measurement technique, it can also provide information on directionality and frequency of machining marks, locate and quantify defects, and generate hundreds of parameters which are difficult or impossible to obtain using two-dimensional techniques.

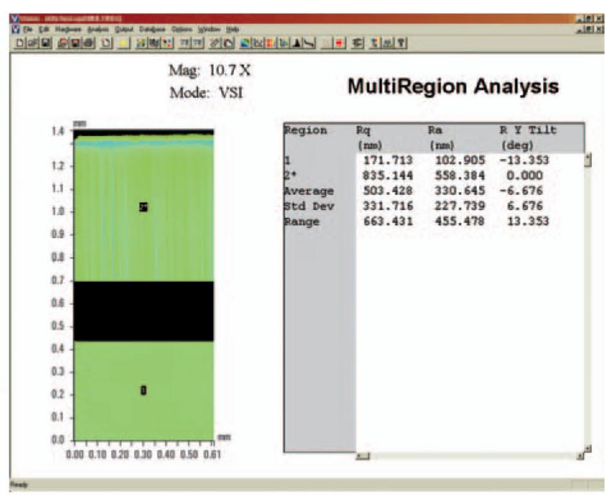
As mentioned above, optical profiling can also be employed to measure blade angles. The blade imaged in Figure 2a includes a single angle relative to the flat part of the strip, whereas premium blades may include three or even four distinct angles. Vision® data analysis software, included with all Wyko optical profilers, features a MultiRegion Analysis which allows a user to define each angled surface and to compare the tilt of each relative to the reference (Figure 2b).

Consumer Razor Blades

Though simple in basic concept, consumer shavers are marketed in a wide array of designs, incorporating multiple blades, lubricating strips and other features for comfort and closeness. In such a competitive market, cost and performance are significant differentiators, and quality control becomes extremely important to drive down product costs.



a.



b.

Figure 2. Multiple angles can be measured using Vision MultiRegion Analysis (Courtesy Cabot Industries).

In multiple-blade razors, the tilt of the individual blades can also be calculated, both relative to each other and relative to a flat reference on the shaver head.

Surgical Blades

Medical blades are typically much sharper and are held to much more stringent process control parameters than consumer blades. Their cutting edges must be exquisitely sharp and defect-free to ensure safe use in demanding medical applications. Again, optical profiling is routinely employed to provide process control data on such devices, both because of its speed and resolution. Because it is a non-contact measurement method, blades can be sampled from the production line without breaking sterilization.

Whereas in Figure 2 the optical profiler characterized the flat surfaces of the blade, the blade edge can also be measured on-end to accurately gauge its sharpness. Figure 3 shows a comparison of the sharpness of a low-grade industrial blade, a consumer-grade razor blade and a surgical scalpel. The curvature of the scalpel has been filtered to provide an accurate assessment of its roughness.

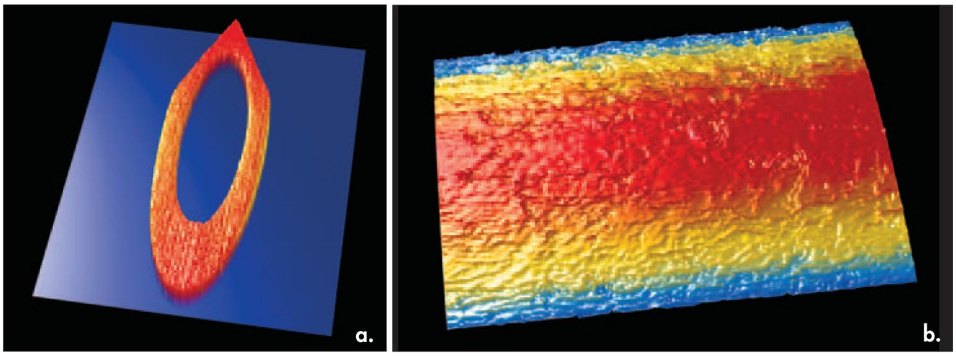


Figure 4. Roughness and shape of medical-grade syringe tip (a) and shank (b).

Measuring Other Sharp Instruments

The efficacy of optical profiling extends to other sharp instruments as well, including syringes and cannulae. Figure 4 shows roughness measurements taken at the tip and along the shank of a syringe. By slicing a syringe lengthwise, the roughness of the ID can also be characterized to ensure smooth fluid flow through the devices.

Conclusion

Optical profiling provides a combination of speed, resolution and reliability that makes the method well-suited for measurement of consumer and medical blades and sharp instruments. The method can be used to characterize the roughness and angles which dictate how well a blade will perform in a given application. The 3D information obtained via optical profiling helps ensure high yields, low costs, and safe, effective medical devices—as well as ensuring a close shave in the morning.

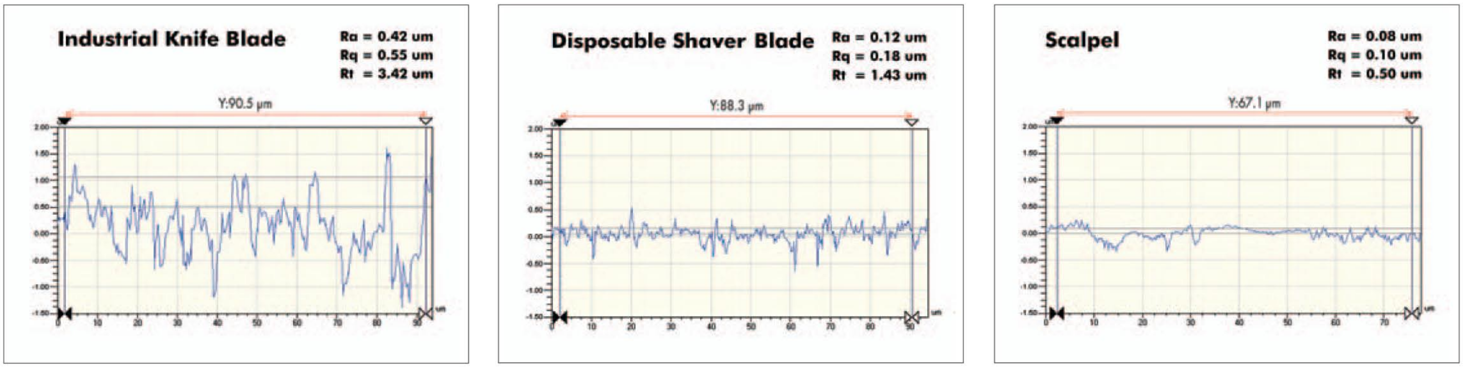


Figure 3. Comparison of average roughness for various types of blades.

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