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Grinding Hypotubes to an Extremely Thin Wall

5 Things You Need to Know

Processing of SST hypotubing to extremely thin wall thickness - achieving a diameter to wall ratio of 100:1 is possible on certain sizes of tubing by a specialized hybrid grinding process. Very consistent wall thickness deviation can be achieved and thus a very high diameter to wall ratio potentially attained.

Grinding Hypotubes to an Extremely Thin Wall

5 Things You Need to Know

Processing of SST hypotubing to extremely thin wall thickness - achieving a diameter to wall ratio of 100:1 is possible on certain sizes of tubing (over .080" diameter ID) by a specialized hybrid grinding process. By grinding both the OD and the ID of the tubes/parts, very consistent wall thickness deviation can be achieved and thus a very high diameter to wall ratio potentially attained.

This fact in itself is pretty eye-opening, but there are other advantages to the Hybrid Grinding Process as it pertains to the processing of thin-walled tubing that could open avenues for the engineer that has run into a manufacturing snag.

#1 GRIND A STRAIGHT OD AND STRAIGHT ID

The simplest form of thin-walled grinding would be a short tube with a straight OD and straight ID. The OD of the tube would be ground by a traditional Centerless Thrufeed process. This would not only be a sizing operation, but also a qualifying operation for diameter size, roundness and consistency. The Hybrid Grinding Process – one that would utilize the qualified OD of the tube as the basis point - would then be employed to grind the ID by a simple reciprocating movement.

Since the locating mechanism for the Hybrid Grinding Process is dependent solely on the diameter of the part itself, the piece can easily be removed from the machine, checked for diameter size or feature integrity and re-introduced to the machine setup without endangering quality or risking wall breakthrough.

Limitations to the length of ID that can be ground do exist. A ratio of approximately 6:1 (length of grind to ID diameter) can be attained.

#2 GRIND A STRAIGHT OD AND STRAIGHT ID (WITH A TWIST)

In the example in #1, however – with a straight OD and a straight ID – DOUBLE the potential length of grind (or a ratio of about 12:1) is possible. This is due to the fact that the part diameter is the sole factor in the location of the part in the machine. For example: a tube with a .250" (6.35mm) outer diameter requires the ID to be ground. Normally a 6:1 ratio can be ground, so therefore a part length of about 1.50" (38mm) would be the maximum length for this operation. However, in this case, the part could be ground to a depth of 1.50" FROM BOTH ENDS – thus attaining a 12:1 depth/diameter ratio or potentially a 3.00" contiguous length of grind in the part. Since the same qualified OD would be the main factor in part location in the machine, the two ends would be ground concentric within microns of one another – virtually eliminating the risk of mismatch where the grinds overlap in the middle of the part.

In both of the examples above, wall ratios of 100:1 or greater are possible. Parts with .240" (6.1mm) OD have been ground consistently with a .002" wall +/-.0002" (.05mm +/-.005mm). This results in a diameter wall ratio of 120:1.

Diameter size limitation of this process would be around .080" (2mm) on the small end of the spectrum and .50" (12.7mm) on the large end.

#3 GRIND A STRAIGHT OD AND MULTIPLE FEATURES IN THE ID

Taking the example in #2 a bit further, not only can an extremely thin wall be produced, but intricate features can be imparted to the ID such as angles, radii, grooves, tapers, etc., by the use of this hybrid process.

A very powerful and flexible CNC control is at the heart of this capability. Features can be imparted by:

1. **interpolation** - by controlling the toolpath of the grinding wheel and using it much like a boring bar on a swiss-type lathe, or by
2. **plunging** (or forming) them into the part by using the CNC control to dress the feature(s) directly into the grinding wheel.

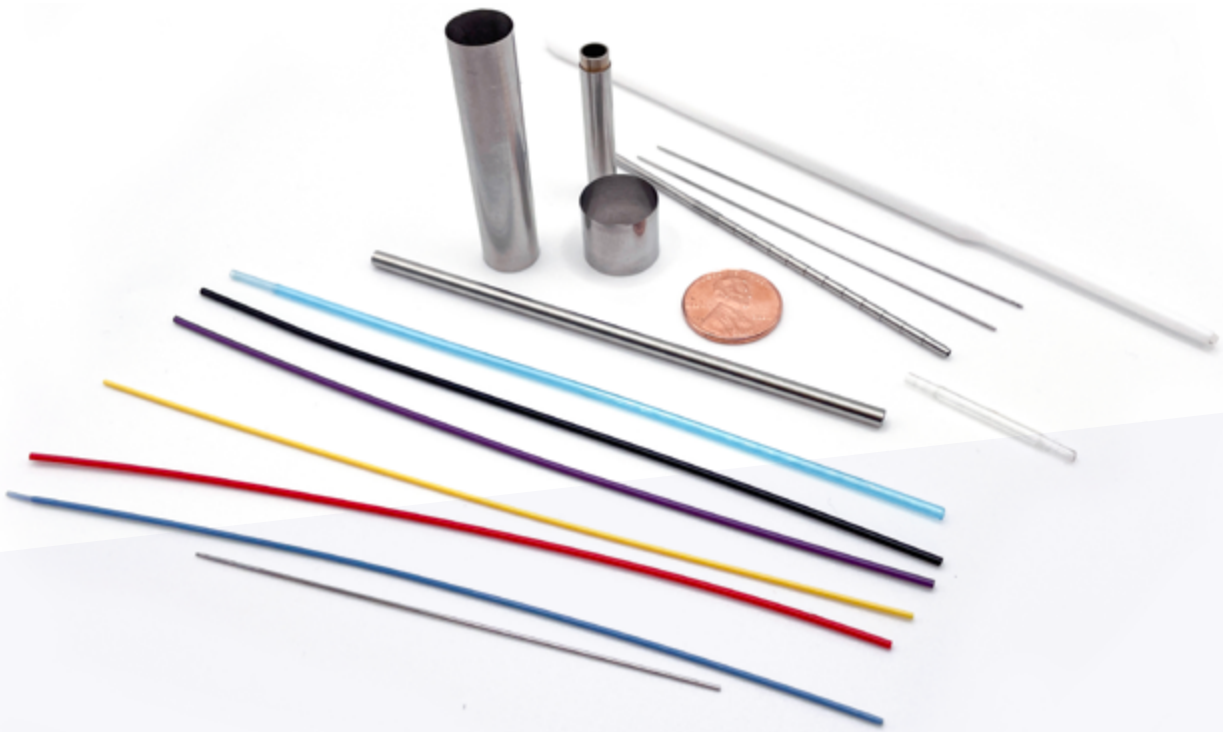
Intricate features can be ground to diameter sizes as small as .100" (2.5mm). Limitations on the process mostly revolve around being able to adequately check the feature being ground – since it is, generally, in a small ID. Destructive testing is always an option with process validation, but it is avoided whenever possible.

Features such as transitional angles to lead from one diameter to another, tip tapering to effectively create a knife edge and groove radii for o-rings are all examples of common internal features ground by this method.

#4 GRIND MULTIPLE FEATURES IN THE OD TOO!

The Hybrid Grinding Process can also be applied to create intricate features on the OD of hypotubes as well. The same process – with a different wheel – allows angles, radii, grooves, bumps, flats, "pointing" (for knife edges) all to be imparted to the parts with perfect concentricity and runout to previously established diameters and features. This means that features ground on the OD, and features or diameters ground in the ID will be concentric within microns since both use the same qualified OD to locate on.

Because of this very close concentricity OD features can be ground to achieve extremely thin cross-sections in the wall. For instance, a groove could be ground into the OD of a tube on which the concentricity has been established to create a wall cross-section of less than .0005" (.013mm) on a diameter as large as .250" (6.35mm) – effectively doubling the diameter wall ratio in short, controlled areas of the tube.



#5 GRIND THIN-WALLED TUBES (BUT SAVE SOME COST)

In situations where diameter-to-wall ratios that approach 100:1 are not necessary a more traditional centerless grinding approach can be applied. Diameter-to-wall ratios of approximately 50:1 can be attained without grinding the ID.

This method would employ a centerless grind operation of the OD only; thru-feed (same diameter all the way across the tube) or in-feed (stepped diameters on the OD of the tube). Since a very time-consuming operation - the ID grind - would be eliminated this process is favored for cost effectiveness.

Walls as thin as .0006" (.015mm) on 30-gauge tubing have consistently been achieved using this process. This particular part also required a larger unground "head" to be left on the part with a much heavier wall thickness, and the majority of the tube being ground to the thin walled diameter.

In the most extreme example of a traditional Thru-Feed application a diameter of .225" (5.7mm) was ground and a .002/.003" (.063mm) wall thickness achieved – resulting in a 90:1 ratio of diameter wall!

Long lengths can be ground by this method. In the example above the tubes were ground in 18" (457mm) lengths. Tubes as long as 12 feet can be ground, but bends in the tubing will interfere with achieving the thinnest walls possible in that length.

It should be noted that since the ID is NOT ground to ensure roundness and concentricity the quality of the raw tubing itself plays a large role in the success of achieving a high diameter-to-wall ratio. If the tubing ID is not round, or not concentric to the OD as initially manufactured, there would be a significant probability of wall break-through as higher ratios are attempted.

Given the examples above it is evident that the selection and employment of an appropriate grinding method can eliminate many manufacturing issues that can arise when designing parts with thin-walled tubing. Being aware of grinding as a viable tool for processing thin-walled tubing – whether it is the Hybrid Process or a more traditional centerless process – is the first step in utilizing its full potential and achieving a positive outcome to a challenging hypotubing project.

ABOUT KMM GROUP, LTD

The KMM Group is a collaborative fusion of three world-class companies: The KVI Group, M&S Centerless Grinding Inc., and Meron Medical. We manufacture mission-critical medical device, aerospace, and other advanced components with exacting precision, leveraging a combined 100-year history of leading-edge milling, turning, grinding, EDM, engineering, and assembly.

Bringing together the brightest minds and the most advanced technologies, we boldly pioneer solutions for extreme manufacturing challenges with passion, perseverance, and integrity. We are an accomplished team of visionaries, continually pivoting to embrace the future of manufacturing today.

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