Patent Attorneys and Surface Texture

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One of the most challenging assignments for a scientist or engineer in a cutting edge technical field is working effectively with a patent attorney. The world of the scientist or engineer is quantitative and precise. The world of the patent attorney is inherently imprecise -- the medium of the patent attorney is words where the medium of the scientist and engineer is mathematics. For each to do her job well, there must be a meeting of the minds. When the invention is in an esoteric field, such as tribology/surface metrology, it is especially important for the inventor to assist the attorney in understanding the novel features of the invention.

The extra effort of the inventor in assisting the attorney in fully understanding her invention will be rewarded with a higher quality patent.
Few patent attorneys are trained in tribology/surface metrology.
Much of the material is inherently mathematical and must be translated into English for the attorney. So, how might an inventor approach this problem of communicating the novel features of her tribology invention to her patent attorney?

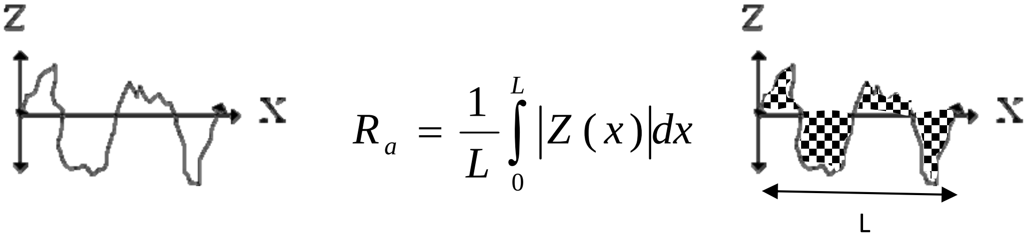
As an example, consider the case of a novel surface finish for a medical device, such as a heart implant, stent, or prosthesis. Assume that without the novel surface developed by the inventor that after implantation the medical device fails prematurely or causes complications. Often, an attorney familiar with medical device technology can be found, but finding a patent attorney knowledgeable in tribology/surface metrology may be difficult. So, in the event that an attorney expert in tribology/surface metrology is unavailable, to develop a quality patent application it is important for the inventor to assist her attorney in understanding her invention.

Assisting the attorney in understanding the invention requires the inventor to take the initiative in clearly identifying the novel features of the invention. For example, assume a novel feature is the "surface roughness" of an implant, stent, or prosthesis. In this case, the inventor must ensure that the attorney understands the concept of "surface roughness." In some cases, it will be appropriate to completely define "surface roughness" in a claim of the patent. In others, the term "surface roughness" is included in a claim and more explicitly defined in the section of the patent application often titled "Detailed Description of the Invention". This decision is generally left to the patent attorney. However, it should not be assumed that the patent attorney understands the concept of "surface roughness" as used by a tribologist/surface metrologist.

Ensuring that the patent attorney understands "surface roughness" is the responsibility of the inventor. For example, the inventor should make clear to the attorney that "surface roughness" may be defined as the average roughness, Ra or a number of other different texture parameters, measured with a particular spatial wavelength bandwidth. Failing to emphasize the importance of specifying the spatial wavelength bandwidth to the attorney may result in a less effective patent than desired. Specifying spatial wavelength bandwidth avoids a potential ambiguity in defining surface roughness, as measurements with different spatial wavelength bandwidths may yield different Ra values.

The following is one example of an explanation of "surface roughness" suitable for assisting a patent attorney in understanding the concept.

When measuring the surface roughness, typically the average roughness, Ra is specified. Ra is a measure of the average of the absolute value of the variation of the surface texture profile about a best fit mean line (Figure 1).
A typical specification for Ra may be 16 µ” or 0.40 µm. The measure of Ra is expressed in units of length since it is a measure of the absolute value of the area under the profile (relative to a mean line) averaged over the length of the profile.



$$R_a = \frac{1}{L}\int_0^L |Z(x)|dx$$

Figure 1. Demonstration of the measurement of Ra.

Along with specifying the surface roughness with Ra one must establish the cutoff lengths (i.e. spatial wavelength bandwidth) used to measure the surface. A specification of Ra alone is inadequate since measurement with different cutoff lengths may result in differences in the measured Ra values.

A surface profile is composed of a spectrum of different spatial wavelength components of various amplitudes. The measured profile will consist of a “filtered” version of the true profile since the instrument will be physically limited in sensing the finest spaced features. The longer wavelength structure detected will be limited by the physical extent of the region measured. Once measured, the resulting raw profile is further filtered by electronics or software algorithms to precisely limit the spatial wavelengths comprising the measured profile.

A typical long wave cutoff, λc for roughness is 0.8 mm which means a 0.8 mm spatial wavelength component that is 1 um peak to valley will be measured as 0.5 um peak to valley after being filtered. Spatial wavelength components longer than 0.8 mm are further attenuated prior to the evaluation of Ra.

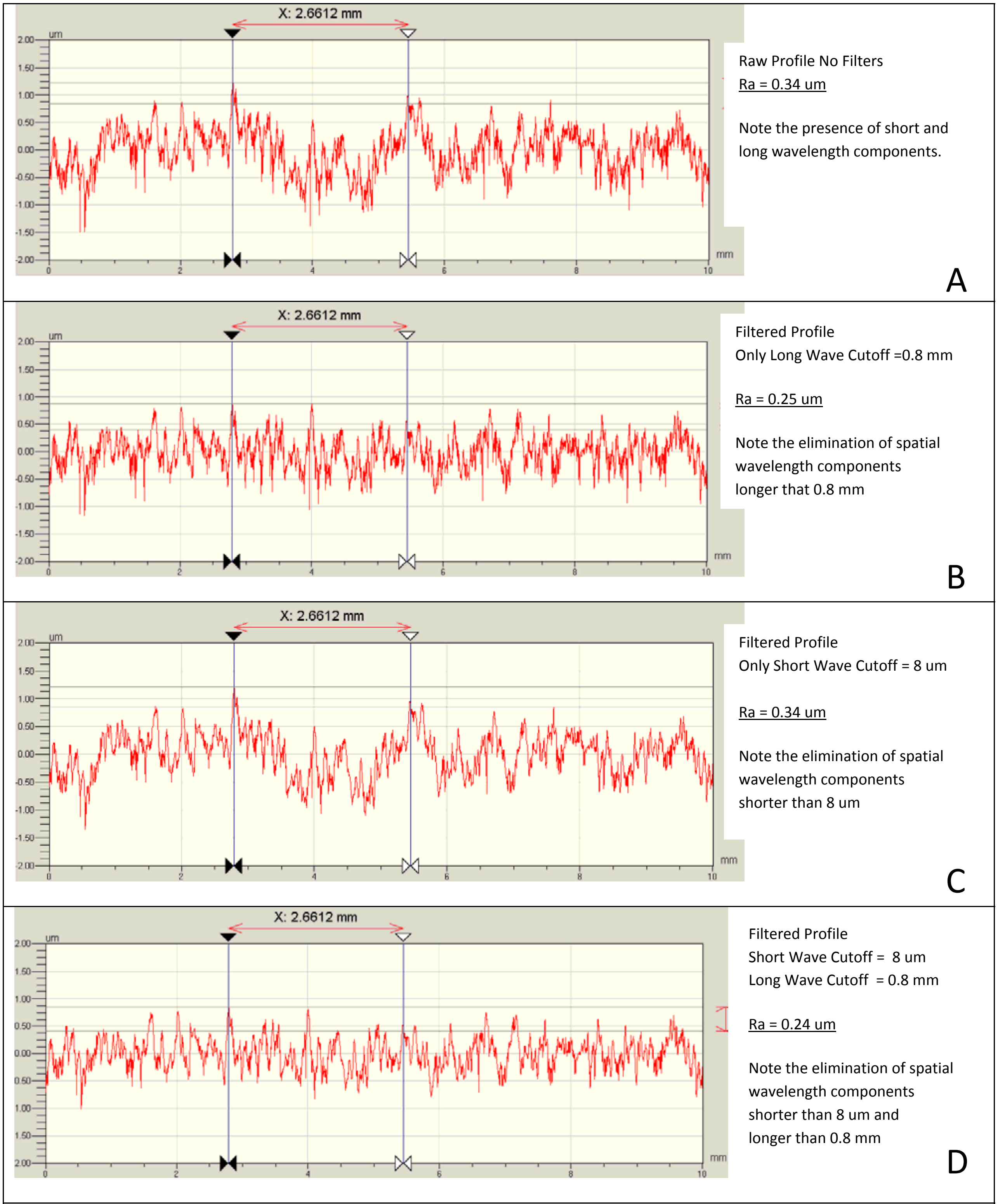
In addition to specifying the long wave cutoff, a short wave cutoff, λs needs to be specified. Typically the ratio of the long wave cutoff to the short wave cutoff is 100:1 or 300:1. Thus a 8 um short wave cutoff may go along with a 0.8 mm long wave cutoff to establish a typical measurement bandwidth.

A short wave cutoff of 8 um means that a 8 um spatial wavelength component that is 0.1 um peak to valley will be measured as 0.05 um peak to valley after being filtered. Spatial wavelength components of less than 8 um are further attenuated prior to the evaluation of Ra.

Figure 2A demonstrates the measurement of a profile without filtering being comprised of many different spatial wavelengths. Applying only the long wave cutoff of 0.8 mm to the measured profile results in the elimination of the “wavy-like” structures (Figure 2B). After applying only the short wave cutoff of 8um the finer spaced structures are attenuated (Figure 2C). Applying both the 0.8 mm long wave cutoff and the 8 um short wave cutoff results in the “band limited” profile displayed in Figure 2D.

As per the ASME B46.1-1995 (Page 36) standard on surface texture specification, the long wave cutoff length, λc must be specified on all drawings. Per the ISO 1302-2002 (Page 9) standard on surface texture, the long wave cutoff length λc and the short wave cutoff length , λs must be specified on all drawings.

The determination of the appropriate cutoff is application specific. Typically the critical area of interaction with mating components, material properties, and the scale of physical phenomena being considered are some of the elements that contribute to the selection of proper measurement cutoff lengths. Note that in some applications it may be necessary to specify a surface with a set of different cutoff lengths to control surface function.



Raw Profile No Filters
Ra = 0.34 um

Note the presence of short and long wavelength components.

Filtered Profile
Only Long Wave Cutoff =0.8 mm

Ra = 0.25 um

Note the elimination of spatial wavelength components longer that 0.8 mm

Filtered Profile
Only Short Wave Cutoff = 8 um

Ra = 0.34 um

Note the elimination of spatial wavelength components shorter than 8 um

Filtered Profile
Short Wave Cutoff = 8 um
Long Wave Cutoff = 0.8 mm

Ra = 0.24 um

Note the elimination of spatial wavelength components shorter than 8 um and longer than 0.8 mm

Figure 3. Demonstration of the measurement of surface profiles without filtering (A),with only a long wave cutoff applied (B), with only a short wave cutoff applied (C), and with both long wave cutoffs and short wave cutoffs applied (D).

Per ISO 1302-2002 the proper specification on a drawing for a surface with a maximum Ra of 0.40 um with a long wave cutoff of 0.8 mm and a short wave cutoff of 8 um would be as follows:

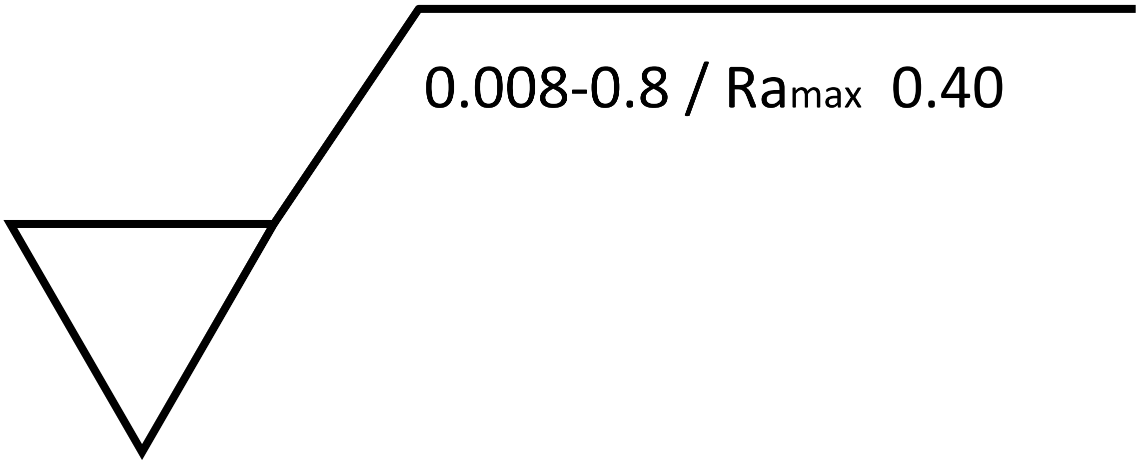


Figure 2. Basic symbol for specifying a Ra of 0.40 um max, over a spatial bandwidth of 0.008mm (i.e. 8 um) to 0.8 mm.

A sample patent claim having a novel "surface roughness" may be written as follows:

1. An apparatus comprising:

a heart pump including a heart pump
external surface having an average roughness
of between about X micrometers and
about Y micrometers measured for a spatial wavelength bandwidth
having a long wavelength cutoff of about A micrometers
and a short wavelength cutoff of
about B micrometers.

In an actual claim, the parameters A and B are the cutoff wavelengths of the measurement system as described above. The parameters X and Y are the "surface roughness" measurements produced by the measurement system at the specified bandwidth as described above.

Along with specifying the average roughness, Ra and the spatial bandwidths there are a number of other texture parameters that may be considered to further describe the class of surface structures that are relevant to the novelty of the device being patented.

The ideas expressed in the article are those of the authors and are not to be construed as legal advice or the work product of Viksnins Harris and Padys PLLP.

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