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THE AREAL Surface texture Handbook



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What is surface texture?

Surface texture refers to the irregularities and variations in the shape and form of a surface when compared to a perfectly smooth and flat surface.

The characteristics of surface texture can significantly impact the appearance, performance, and functionality of a product. Surface texture plays a critical role in determining the friction, wear resistance, and adhesion properties of a surface, among other factors. Understanding the role of surface texture in product design and manufacturing can help optimize performance and ensure that products meet the required specifications.

Surface texture, topography and roughness

The terms surface texture, roughness, and topography are often used interchangeably, but they do not have the same meaning.

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Surface **topography** is the overall structure of the surface of a part, including all its features treated as a continuum of spatial wavelengths. Surface **form**, on the other hand, refers to the underlying shape of a part, such as the spheric form of a lens. Once the form is removed, the remaining surface features are considered surface **texture**, including both roughness and waviness.

Roughness refers to the small-scale components of the surface, while **waviness** pertains to larger-scale features. The term "surface finish" is often used to refer to surface texture, but it typically pertains specifically to roughness. Meanwhile, "surface lay" is commonly used to refer to the orientation of the texture, although this term is more frequently used among American English speakers.



Figure 2. Wavelength components of a topography.



Surface texture terminology

The following definitions included in ISO 25178 are basic for understanding surface texture characterization and roughness parameters extraction.

- Primary surface: portion of the surface obtained as a result of applying an S-filter to the measured region of the workpiece. When this surface is represented by a finite set of data points, we should talk about the primary extracted surface.
- **Surface filter:** an operator used to filter a surface, typically applied to a primary extracted surface.
- Nesting index: it represents the threshold wavelength for surface filters and is expressed in units of length (usually microns). The nesting index may be called the "cutoff value" in specific contexts due to its correspondence with this parameter in the profile method. Essentially, the nesting index determines the level of smoothing applied to an areal surface, ensuring that only relevant features are retained.
- S-filter: a surface filter that acts as a long-pass filter (low-pass in frequency) by discarding small-scale lateral components from the surface and resulting in the primary surface. The nesting index for the S-filter can be refered to as Nis or Nic depending on the order of the S-filter with respect to the F-operator and thus the wavelength component that it removes (microroughness/roughness).

Figure 3. Effect of an S-filter with nesting index Nis on the wavelength components of a surface.

■ L-filter: short-pass filter (high-pass in frequency) that eliminates large-scale lateral components from either the primary surface or the S-F surface. It is specifically designed to remove undulations and other lateral components from the surface, enabling the extraction of roughness components. The nesting index for the L-filter is always refered to as Nic.



Figure 4. Effect of an L-filter with nesting index Nic on the wavelength components of a surface.

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- **F-operator:** suppresses the form from the primary surface by, for example, subtracting a least-squares plane or cylinder. Since many L-filters are sensitive to form, an F-operator is often applied as a prefilter before using L-filters.
- **S-F surface:** obtained by applying an F-operator to the primary surface, which has already been filtered with an S-filter. This process eliminates both small wavelength components and form components.
- S-L surface: surface in which small wavelength components have been removed using an S filter, followed by the elimination of large wavelength components using an L-filter. This can be done by applying an L-filter to the S-F surface or the primary surface.



Figure 5. Scheme showing how the S-F and S-L surface are generated by the different filters and its wavelength components.

- Scale-limited surface: the foundation for calculating areal surface texture parameters. It refers to either the S-F or S-L surface and is sometimes known as the "surface". This surface type is comparable to the roughness or waviness profile of the surface in the profile method.
- **Reference surface:** an essential component associated with the scale-limited surface that serves as the basis for calculating surface texture parameters. While a plane at mean height is the most common reference surface, other examples include cylinders and spheres.



Figure 6. Example of a reference surface, in this case a mean plane of a scale-limited surface.

Evaluation area: a rectangular portion of the surface used for extraction purposes. In order to ensure accuracy, typically, the sides of the rectangular area must be parallel or orthogonal to the nominal geometry because it depends on the function of the surface. The evaluation area is a square unless otherwise specified for S-F and S-L surfaces.

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