



REFERENCE

Surface Finish Reference: Ra, SPI, VDI, and Coatings

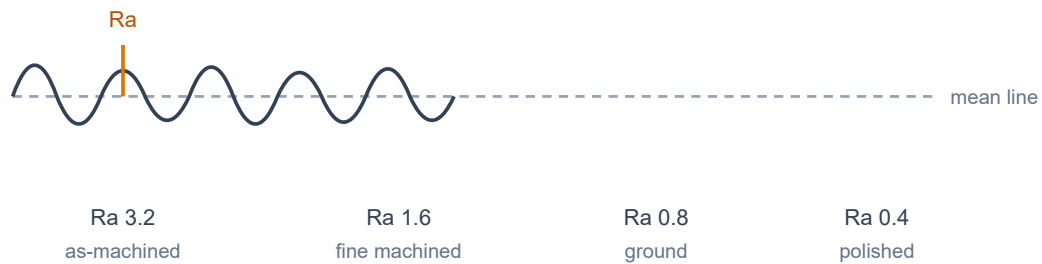
How surface finish is measured (Ra, Rz, Rq), the SPI and VDI mold-texture scales, and how to match platings and coatings to aluminum, steel, and stainless.

Surface finish is both cosmetic and functional. It sets how a part looks and feels, but also how it seals, slides, wears, bonds paint, and resists corrosion. Specified well, a finish is called out only where it matters; specified loosely, it either disappoints on the show face or adds cost everywhere. This reference explains how finish is measured, the common scales, and the plating and coating options by material.

The measurement standard behind this is ASME B46.1 for surface texture. The mold-texture scales (SPI and VDI 3400) and the plating specifications are public industry standards. Where a finish is a FabWorks-quotable option, the DFM engine checks it against the material for compatibility.

Measuring roughness: Ra, Rz, Rq

Roughness average (Ra)



Ra is the average deviation from the mean line, in micrometers. Lower Ra means finer and costlier.

Roughness is the fine, closely spaced surface texture, measured as a deviation from a mean line over a sampling length, in micrometers (or microinches).

- Ra, the roughness average, is the arithmetic mean deviation from the mean line. It is the most common single number and the default unless stated otherwise.
- Rz, the average maximum height, averages the peak-to-valley heights over several samples. It captures the worst features that Ra can average away, useful for sealing faces.
- Rq (RMS), the root-mean-square deviation, weights larger deviations more; it appears on optical and precision specifications.

Ra is the right callout for most parts. Specify Rz where a single peak or valley, a scratch on a seal face, would matter more than the average.

Machined finish reference

Finish	Ra (um)	Ra (uin)	Method
As-machined	1.6 to 3.2	63 to 125	Standard milling and turning, visible tool marks
Fine machined	0.8 to 1.6	32 to 63	Controlled setup, finishing pass
Ground	0.4 to 0.8	16 to 32	Grinding

Finish	Ra (um)	Ra (uin)	Method
Polished	below 0.4	below 16	Successive polishing

Mold and cast surface scales

Molded and cast parts inherit the tool's surface, so finish is specified on the tool.

Mold finish scales: SPI and VDI

SPI (polish)



VDI 3400 (spark)



SPI grades a polished tool; VDI 3400 a spark-eroded texture. Both map to a target Ra.

- SPI, the polish scale, runs from A1 (a lens-grade mirror) through B and C grades to D3 (a blasted matte), grading how a mold is polished. A-grades give gloss parts, D-grades a matte texture.
- VDI 3400 grades a spark-eroded (EDM) texture by a number: a lower VDI number is smoother, a higher one coarser. It is the standard way to specify an even, engineered texture on a molded surface.

Both map to a target Ra on the finished part, so a texture can be matched across tools.

Platings and coatings by material

The right coating depends on the substrate, and not every coating pairs with every metal.

Coating	Substrate	Purpose
Anodize Type II	Aluminum	Corrosion resistance and color, 12 to 25 um oxide
Hard anodize Type III	Aluminum	Wear surface, 25 to 50 um, high surface hardness
Powder coat	Steel, aluminum	Durable colored finish
Zinc plate	Carbon steel	Corrosion protection on steel (not aluminum)
Passivation	Stainless steel	Restores the corrosion-resistant oxide layer
Bead blast	Most metals	Uniform matte cosmetic, removes tool marks
Electroless nickel	Steel, aluminum	Even hard, corrosion-resistant layer

Aluminum anodizes but does not take zinc plating; carbon steel takes zinc or powder coat but not anodize; stainless is passivated rather than plated. Choose the finish with the substrate in mind.

The checklist

1. Finish called out only on the faces that need it, with a target Ra.
2. Ra for general use, Rz where a peak or valley matters.
3. Mold and cast textures specified on the SPI or VDI scale.
4. Plating or coating matched to the substrate.
5. A cosmetic show surface identified so it can be oriented and protected.

How FabWorks checks this for you

When you choose a finish in a quote, our DFM engine confirms it against the material, flagging an incompatible pairing (anodize on steel, zinc on aluminum) before it reaches the floor. Each compatibility rule is grounded in the surface-texture and plating standards behind it. The result is a finish that is achievable on your material and specified only where it earns its cost.