SURFACE TEXTURE: Electropolishing and Ra

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Introduction

The irregularity of a machined, ground, hand or machined polished stainless steel surface is the result of mechanical processes employed. This irregularity consists of high and low spots produced on the surface by the tool bit, the grinding wheel or the polishing mop. These peaks and valleys can be measured and used to define the condition and sometimes the performance of the surface. There are more than 100 ways to measure a surface (see section below) and analyse the results, but the most common assessment of the surface texture is by its roughness measurement.

The most common parameter for surface texture is Ra or Roughness Average, also known as CLA or Centre Line Average. Ra is calculated by an algorithm that measures the average length between the peaks and the valleys and the deviation from the mean line on the entire surface within the sampling length.
Ra averages all peaks and valleys of the roughness profile and then neutralises the few outlying points, so that the extreme points have no significant impact on the final results. It is a simple and effective method for monitoring surface texture and ensuring consistency in the measurement of multiple mechanically finished surfaces.

Surface Roughness Profile Parameters

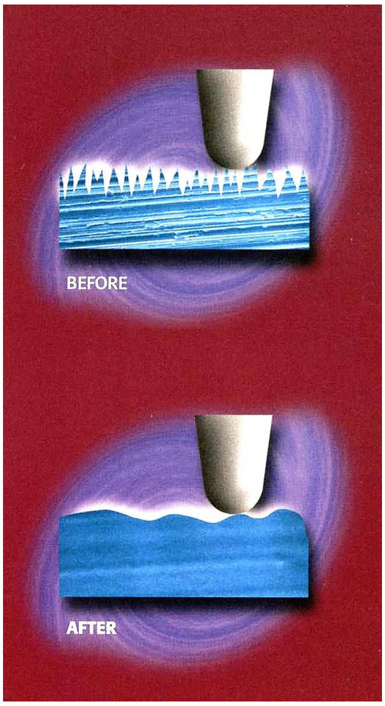
Parameter	**Name**
Ra	Roughness Average (Ra)
Rq	Root Mean Square (RMS) Roughness
Rt	Maximum Height of the Profile
Rv, Rm	Maximum Profile Valley Depth
Rp	Maximum Profile Peak Height
Rpm	Average Maximum Profile Peak Height
Rz	Average Maximum Height of the Profile
Rmax	Maximum Roughness Depth
Rc	Mean Height of Profile Irregularities
Rz(iso)	Roughness Height
Ry	Maximum Height of the Profile
Wt, W	Waviness Height
S	Mean Spacing of Local Peaks of the Profile
Sm, RSm	Mean Spacing of Profile Irregularities
D	Profile Peak Density
Pc	Peak Count (Peak Density)
HSC	Hight Spot Count
λa	Average Wavelength of the Profile
λq	Root Mean Square (RMS) Wavelength of the Profile
Δa	Average Absolute Slope
Δq	Root Mean Square (RMS) Slope
Lo	Developed Profile Length
lr	Profile Length Ratio
Rsk,Sk	Skewness

Electropolishing and surface texture

The characteristics of a surface produced on stainless steel by electropolishing vary significantly to those of a surface achieved by mechanical means. The metal is electrochemically eroded rather than abraded, so that no mechanical forces are involved. Peaks are preferentially removed, resulting in a micro-smooth, reflective finish. The macro-topology is barely affected – the process has been likened to removing the trees and boulders from the landscape, but leaving the hills and valleys intact.
Conventional surface measuring instruments rely upon a precision stylus traversing over a small sampling length. In the case of a micro-smooth electropolished finish, the stylus can travel unimpeded up hills and down valleys. On occasion, this has produced a higher Ra reading than that of the surface prior to electropolishing. The implication is that electropolishing has roughened the surface detrimentally. Scanning electron microscope images, however, show the electropolished surface to be infinitely smoother than the ground finish. This is illustrated below.

SCHEMATIC DIAGRAMS SHOWING A STYLUS TRAVERSING A FINELY GROUND SURFACE AND THE SAME SURFACE AFTER ELECTROPOLISHING

DEPENDING UPON THE SIZE OF THE STYLUS TIP, IT IS POSSIBLE TO OBTAIN A HIGHER Ra READING FOR THE ELECTROPOLISHED SURFACE, SUGGESTING FALSELY THAT THE GROUND FINISH IS THE SMOOTHER.




A


B

THE 'BEFORE' AND 'AFTER' EFFECT OF ELECTROPOLISHING

A -240 GRIT MECHANICAL FINISH ON STAINLESS STEEL

B –ELECTROPOLISHED FINISH ON A 240 GRIT GROUND SURFACE