

Surface Finish and the Fotonic Sensor

Introduction

MTI Instruments has run a series of experimental tests using a standard MTI-1000 Fotonic Sensor looking at various surface finish samples. These tests were conducted by adjusting the MTI-1000 for normal operation against a 2-L surface; and then without changing this adjustment, other surface samples were substituted. 2L is a finely lapped, mirror-like surface. The additional samples were 8L, 16G, 63G, 63P, and 125M. These are considered “standard” surface finish reference numbers used throughout the machine tool industry and represent a wide variation in finishes.

Preparation

When using the Fotonic Sensor to measure smoothness or surface finish, the probe is usually separated from the target (specimen) at a distance which puts the standard Fotonic Sensor curve at its output peak. The output is comparatively insensitive to displacement resulting from non-flat surfaces or slight deviation from true perpendicularity of the probe. The Fotonic Sensor then becomes sensitive only to smoothness or color changes.

Surfaces under observation should be clean and free from oil, rust and dirt. The calibration standards should be of the same general color as the item to be observed. Since no carrier frequencies are used in the electronics and the frequency response of the pickup goes as high as 2 MHz; it is possible to scan larger surfaces faster. In-line examination of the entire surface of all parts is also practical. The Fotonic Sensor can detect surface scratches smaller than a microinch wide or deep. Without motion, the instrument may integrate smoothness over the entire area being viewed

Advantages Over Stylus Measurements

Fotonic Sensors have several fiber optic arrangements and each have somewhat different capabilities. It is possible to measure smoothness without even moving the probe or part; whereas motion is necessary with stylus measuring means. Since most surfaces have a different roughness in different planes or directions, it is often difficult to say just what overall finish actually is. A groove may have a very smooth bottom in which the stylus rides - and a very rough side and peak. The roughness of a surface may vary over several orders of magnitude when measured with a stylus, depending upon the direction of measurement.

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Advantages - Cont'd.

Friction and wear are more a function of average smoothness. Therefore, since the Fotonic Sensor tends to integrate the surface being observed, the results often tell a more conclusive story than findings obtained by running a stylus down a groove. More consistent indication of fluid seal leakage is possible using the Fotonic Sensor than with the traditional stylus types of surface finish measurement. Except for the obvious scratch through which fluid may leak, the leakage seems to be related to peak or ridge roughness which elevates the seal from the surface dynamically or statically.

It is also possible to measure surface smoothness during machining on a cut previous to the last or even during the final machining operation. One can then change conditions before scrapping a part which is "one dimension" but which may have an inferior surface finish. Adaptive and "on line" measurements of finish are therefore practical and can be made a part of existing and future machines.

The Results

The graph below shows these results. We then mathematically normalized each output curve and plotted them individually as compared to the reference 2L surface.

These results are significant in that they show a relatively small error in our standard calibration procedure regardless of the extreme variation in surface finish and condition. This accuracy exists up to a No. 63 surface finish with only about a .5 mil equivalent displacement error up to a No. 500 surface. The dynamic error, i.e. slope of calibration curve, is nearly undetectable and is probably less than the experimental error of the tests themselves.

