

TOPOGRAPHY & ROUGHNESS TESTING OF SANDPAPER SURFACE



Prepared by **Benjamin Mell**

6 Morgan, Ste156, Irvine CA 92618 · P: 949.461.9292 · F: 949.461.9232 · nanovea.com Today's standard for tomorrow's materials. © 2010 NANOVEA

INTRO:

Sandpaper is a type of paper whose surface has been fixed with an abrasive material. Sandpaper is used to remove small amounts of surface material in order to make the surface either smoother or rougher. Another use for sandpaper is to remove a layer, or coating, of material from the surface, such as paint. The form, or shape, of sandpaper used in this application is sheet sandpaper (9 x 11 inches). Rolls, belt, and disk are other varieties of sandpaper. The abrasive material used for this application is aluminum oxide. This material is very common in a wide variety of grits. Aluminum oxide can be used on metallic or wooden surfaces. Aluminum oxide exhibits a high degree of friability. Friability, in this instance, means that the aluminum oxide fragments when heat and pressure are applied. The fragmentation of the aluminum oxide creates new, sharp edges. Aluminum oxide sandpapers last longer than most other sandpapers due to this self-renewing property.

TEST METHOD:

The particle size of the abrasive material, which is embedded in the sandpaper, is referred to as grit size. Typically, the higher the grit number the smoother the sandpaper and the lower the grit number the rougher the sandpaper. Using our Nanovea ST400, the height of the grit can be measured for many varieties of sandpaper. In addition, roughness values can be calculated for this measurement. Information such as this can provide details about how the sandpaper will wear down over time or how the sandpaper will react to heat and moisture (before-and-after testing). These details are useful when studying the bonding agent of the sandpaper, which keeps the abrasive material attached to the paper backing. Phenolic resin and hide glue are examples of sandpaper bonding adhesives. Another piece of information that can be computed from this type of testing is the number of abrasive particles over a given area of sandpaper. This is important in making sure that the embedding of abrasive particles on the surface of the sandpaper is consistent (form of quality control). Our instrument is also helpful in measuring the average abrasive particle diameter of varying sandpaper grits.

In this application, the Nanovea ST400 is used to compare roughness values between several sandpaper grits manufactured by 3M. In doing so, we expect to observe the roughness values decrease as the sandpaper grits increase. Also, in this application note, we compare two sandpapers with the same grit number that is made by 3M and Norton, for 60 and 120 grit. (*The sandpapers used in this application note are commercially available*).



MEASUREMENT PRINCIPLE:

The axial chromatism technique uses a white light source, where light passes through an objective lens with a high degree of chromatic aberration. The refractive index of the objective lens will vary in relation to the wavelength of the light. In effect, each separate wavelength of the incident white light will re-focus at a different distance from the lens (different height). When the measured sample is within the range of possible heights, a single monochromatic point will be focalized to form the image. Due to the confocal configuration of the system, only the focused wavelength will pass through the spatial filter with high efficiency, thus causing all other wavelengths to be out of focus. The spectral analysis is done using a diffraction grating. This technique deviates each wavelength at a different position, intercepting a line of CCD, which in turn indicates the position of the maximum intensity and allows direct correspondence to the Z height position.



The spectral analysis is done using a diffraction grating. This technique deviates each wavelength at a different position, intercepting a line of CCD, which in turn indicates the position of the maximum intensity allowing direct correspondence to the Z height position. Nanovea optical pens have zero influence from sample reflectivity. Variations require no sample preparation and have advanced ability to measure high surface angles. Capable of large Z measurement ranges. Measure any material: transparent/opaque, specular/diffusive, polished/rough. Measurement includes: Profile Dimension, Roughness Finish Texture, Shape Form Topography, Flatness Warpage Planarity, Volume Area, Step-Height Depth Thickness and many others.

MEASUREMENTS TIPS:

When measuring different sizes of sandpaper grit, the measurement area should not always be the same. Coarse (low grit) sandpaper requires larger measurement areas than fine (high) grit sandpaper, due to the larger abrasive particles on the surface. Also, fine sandpaper requires better lateral resolution (smaller step sizes) than coarse sandpaper.

TEST RESULTS:

Grit	Common Name	Uses
30-60	Coarse	Heavy sanding and stripping; roughing the surface
80-120	Medium	Smoothing the surface; removing small imperfections/marks
150-180	Fine	Final sanding of surface before finishing
220-240	Very Fine	Sanding between coats of stain or sealer

220 Grit





Abrasive Material	Wood	Metal	Paint	Fiberglass	Plastic
Aluminum Oxide	Х	Х	Х	Х	Х
Silicon Carbide	-	Х	Х	Х	Х
Garnet	Х	-	-	-	-
Ceramic	Х	-	-	-	-

	Grit	Average Particle Diameter (µm)
	36	530-538
Coarse	50	336-348
	60	265-269
	80	190-201
Medium	100	140-162
	120	115-125
Fine	150	92-100
	180	82
Very Fine	220	68

3M 60 GRIT



NORTON 60 GRIT



3M 120 GRIT



NORTON 120 GRIT



TEST RESULTS AND DISCUSSION:

Company	Grit	Ssk	Sku	Sq (µm)	Sp (µm)	Sv (µm)	Sz (µm)	Sa (µm)
3M	36	0.7415	3.632	154.6	879.2	339.9	1219	122.8

3M	50	0.7821	3.663	113.8	692.6	276.8	969.4	90.74
3M	60	0.8474	3.586	83.82	549	256.7	805.8	67.09
Norton	60	0.6728	4.083	71.47	440.4	198.7	639.1	55.4
3M	80	0.8926	3.508	66.53	335	185.2	520.2	53.81
3M	100	1.099	4.135	41.05	266.5	103.6	370.1	32.42
3M	120	1.099	4.187	31.18	203.6	69.59	273.2	24.41
Norton	120	1.051	5.323	27.93	208.4	83.84	292.2	21.28
3M	150	1.284	5.112	22.17	170.5	59.45	229.9	16.89
3M	180	1.123	4.63	22.49	137	61.17	198.1	17.43
3M	220	1.091	4.676	18.54	117.4	52.15	169.6	14.26

From the roughness results, we can observe that, for the most part, the average roughness (Sa) value decreased as the sandpaper grit number increased. However, our results proved there was a discrepancy from what we had expected prior to our testing. The roughness value for the 180 grit sandpaper was actually higher than the roughness value for the 150 grit sandpaper. This would be a very interesting discovery for a sandpaper manufacturer and would most likely initiate further investigation or quality control. Also, we can observe from the roughness results that even though the sandpaper grit numbers were the same, 60 and 120, the sandpaper produced by Norton had lower roughness values than the roughness values for the sandpaper made by 3M.

3M 60 GRIT

NORTON 60 GRIT



A range of Optical Pens were needed for this application. The 400µm Pen was used for the fine sandpapers, using step sizes of 25µm (lateral resolution). The 1.2mm and 3.5mm Pens were used for the coarse and medium sandpapers, using step sizes of 50µm.

Definition

Ssk	Skewness	Skewness of the height distribution $\int_{Ssk} = \int_{Sq^{*}} \int_{A} \int_{A} Z^{*}(x, y) dx dy$ (ness qualifies the symmetry of the height distribution. A negative Ssk indicates that the s mposed of mainly one plateau and deep and fine valleys. In this case, the distribution is s to the top. A positive Ssk indicates a surface with a lot of peaks on a plane. Therefore, the distribution is sloping to the bottom. Due to the large exponent used, this parameter is ve sensitive to the sampling and noise of the measurement.
Sku	Kurtosis	Kurtosis of the height distribution $\frac{1}{Sku} = \frac{1}{Sq} \left[\frac{1}{A} \int \int_{A} z^{*}(x, y) dx dy \right]$ Kurtosis qualifies the flatness of the height distribution e to the large exponent used, this parameter is very sensitive to the sampling and noise or measurement.
Sq	Root Mean Square Height	Standard deviation of the height distribution, or RMS surface roughness $Sq = \sqrt{\frac{1}{4} \iint_{A} Z^{*}(x,y) dx dy}$ Computes the standard deviation for the amplitudes of the surface (RMS)
Sp	Maximum Peak Height	Height between the highest peak and the mean plane
Sv	Maximum Pit Height	Depth between the mean plane and the deepest valley
Sz	Maximum Height	Height between the highest peak and the deepest valley
Sa	Arithmetical Mean Height	Mean surface roughness $Sa = \frac{1}{A} \int_{A} \mathbf{Z}(x, y) \mathbf{d}x dy$

CONCLUSION:

In conclusion, Nanovea Profilometers can be used to compare roughness values between different surfaces, compute the average abrasive particle diameter, and measure the number of abrasive particles in a given area. The measurement technique used by the Nanovea Profilometers require no stitching of images to measure large surface area and intricate angles (edges) of abrasive particles can be measured without dropping data points. Lastly, Nanovea Profilometers are a superior solution for measuring changes in surface roughness for quality control and/or research environments. Special areas of interest could have been further analyzed with integrated AFM module on table top models. Nanovea 3D Profilometers speeds range from 20mm/s to 1m/s for laboratory or research to the needs of hi-speed inspection; can be built with custom size, speeds, scanning capabilities, Class 1 Clean Room compliance, with Indexing Conveyor and for Inline or online Integration. To learn more: <u>Nanovea Profilometers</u>.