moore tool

DEFINITION OF AN OPTICAL SURFACE

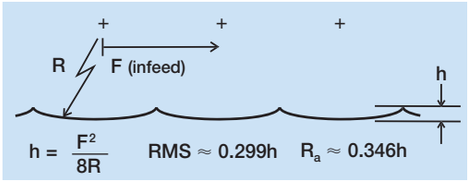
$$Z = \frac{CX^2}{1 + [1-(K+1)\,C^2x^2]^{1/2}} + A_1X^4 + A_2X^6 + A_3X^8 + A_4X^{10} + \ldots$$

Z	=	Sag of surface parallel to Z axis
X	=	Radial distance from axis
C	=	Curvature = 1/R = 1/Radius of curvature
A_1, A_2, A_3, A_4	=	Aspheric deformation constants
K	=	Conic constant
K < -1	⇒	Hyperboloid
K = -1	⇒	Paraboloid
-1 < K < 0	⇒	Prolate ellipsoid (major)
K > 0	⇒	Oblate ellipsoid (minor)
K = 0	⇒	Sphere

VISIBLE SPECTRUM

Red	.622 – .770 µm
Orange	.597 – .622 µm
Yellow	.577 – .597 µm
Green	.492 – .577 µm
Blue	.455 – .492 µm
Violet	.390 – .455 µm

THEORETICAL SURFACE FINISH



SURFACE FINISH AND PROFILE

R_a = Arithmetic Average Roughness

R_q = RMS = Root Mean Square Roughness

R_t = Peak to Valley Roughness

R_{sk} = Skewness

R_{ku} = Kurtosis

REFERENCES

Evans, Chris, Precision Engineering: An Evolutionary View, Bedford, UK, Cranfield Press, 1989

Hale, Layton C., "Principles and Techniques for Designing Precision Machines," Ph.D. Thesis, Massachusetts Institute of Technology, Cambridge, MA, 1999

Jones, R.V., Instruments and Experiences: Paper on Measurement and Instrument Design, John Wiley & Sons, 1988

Moore, Wayne R., Foundations of Mechanical Accuracy, Bridgeport, CT, Moore Special Tool Company, 1989

Slocum, Alexander H., Precision Machine Design, Dearborn, MI, Society of Manufacturing Engineers, 1992

Smith, Stuart T., Flexures Elements of Elastic Mechanisms, New York, Gordan and Breach Science Publishers, 2000

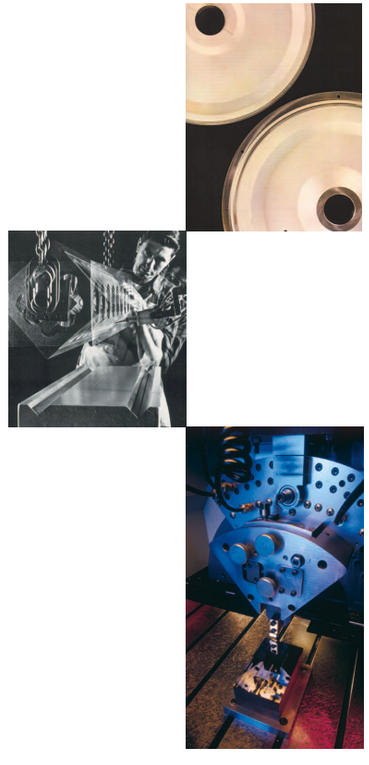
Smith, Stuart T. and Chetwynd, D. G., Foundations of Ultraprecision Mechanism Design, Switzerland, Gordan and Breach Science Publishers, 1992

Moore Tool Company, Inc.
800 Union Avenue
Bridgeport, CT 06607-0088
P 203 366 3224
www.mooretool.com

Moore Nanotechnology Systems LLC
426A Winchester Styreet
Keene, NH 03431-0605 USA
Phone 603 352 3030
Fax 603 357 3363
www.nanotechsys.com

RG 5.08

PRECISION ENGINEERING REFERENCE GUIDE



GEOMETRY

Roundness

Concentricity

Position

Cylindricity

Straightness

Parallelism

Perpendicularity

Flatness

Circular Runout

Total Runout

PRECISION ENGINEERING CONVERSION FACTORS

Displacement

		.001 inch	=	**10^{-3}** inch	=	**25.4** micrometers
1 microinch	=	**1** µinch	=	**10^{-6}** inch	=	**25.4** nanometers
1 micrometer	=	**1** µm	=	**10^{-6}** meter	≈	**40.0** microinches
1 nanometer	=	**1** nm	=	**10^{-9}** meter	≈	**0.04** microinches

Angular

1 arc minute	=	**1/60** degree	≈	**0.01667** degrees		
1 arc second	=	**1/3600** degree	≈	**0.000278** degrees		
1 arc minute	≈	slope of **291** µin/inch				
1 arc second	≈	slope of **4.8** µin/inch	=	**4.8** µm/m		
1 radian	=	**1** rad	=	(**360/2π**) degrees	≈	**57.3** degrees
1 milliradian	=	**1** mrad	=	**10^{-3}** rad	≈	**3.4** arc minute
1 microradian	=	**1** µrad	=	**10^{-6}** rad	≈	**0.21** arc seconds
1 microradian	=	slope of **1** µin/inch	=	slope of **1** µm/m		

Miscellaneous

1 lbf/µin	=	**1 x 10^{6}** lbf/in	≈	**175** N/µm		
1 N/µm	≈	**5710** lbf/in				
1 lbf	=	**4.448** N				
1 N	=	**0.2248** lbf				
1 lbm	=	**0.4536** kg				
1 kg	=	**2.2046** lbm				

METROLOGICAL LASERS

HeNe Laser	⇒	1 λ	=	2 Fringes	=	6328 Å	=	.6328 µm	=	24.913 µ"
CO_2 Laser	⇒	1 λ	=	2 Fringes	=	106000 Å	=	10.6 µm	=	417.3 µ"

MATERIAL PROPERTIES

	Mass Density Mg/m^3	Elastic Modulus GPa	Thermal Expansion 10^{-6}/°C	Thermal Conductivity W/m/°C	Specific Heat KJ/kg/°C
Aluminum 6061	2.71	71.0	23.0	177.0	0.896
Aluminum Oxide	3.9	380.0	8.5	25.0	0.79
Beryllium	1.85	304.0	11.6	180.0	1.9
Brass	8.4	105.0	20.0	120.0	0.38
Bronze	8.4	120.0	19.0	85.0	0.38
Gray Cast Iron	7.4	125.0	11.0	46.0	0.525
Copper	8.9	117.0	17.0	397.0	0.38
Fused Silica	2.2	72.0	0.56	1.4	0.741
Granite	2.6	76.0	6.0	1.6	0.82
Invar	8.03	148.0	1.2	11.0	0.46
Nickel	8.9	210.0	13.0	86.0	0.45
PMMA	1.2	3.3	70.0	0.2	1.5
Polycarbonate	1.2	2.2	120.0	0.2	1.9
Polystyrene	1.1	3.2	70.0	0.43	1.4
PTFE	2.2	3.5	100.0	0.25	1.05
Silicon (single crys.)	2.33	130.0	2.3	148.0	0.75
Silicon Carbide	3.2	410.0	4.3	84.0	1.4
Silicon Nitride	3.2	310.0	3.2	17.0	0.63
Stainless Steel 304	8.0	193.0	17.3	16.2	0.5
Steel	7.8	210.0	12.0	54.0	0.46
Super Invar	8.15	144.0	0.5	11.0	0.46
Titanium	4.4	115.0	10.0	7.2	0.565
Tungsten Carbide	14.5	550.0	5.1	108.0	0.23
ULE® glass	2.21	67.6	0.02	1.3	0.767
Zerodur®	2.53	91.0	0.05	1.6	0.821
Zirconium Oxide	5.6	200.0	10.5	1.5	0.67