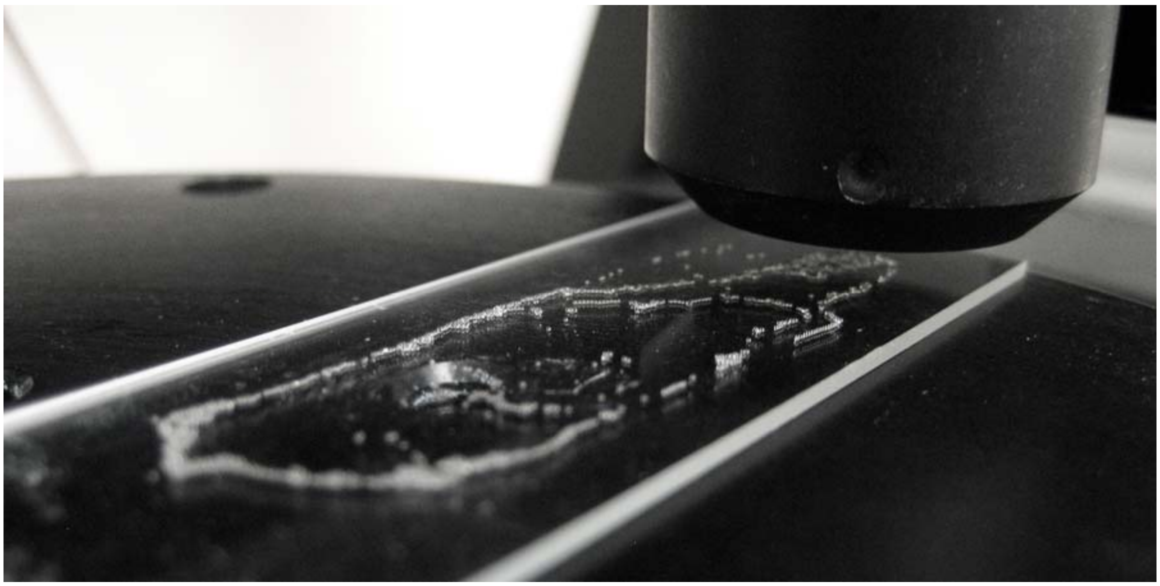
MICROSPHERE DIMENSIONS
USING 3D PROFILOMETRY



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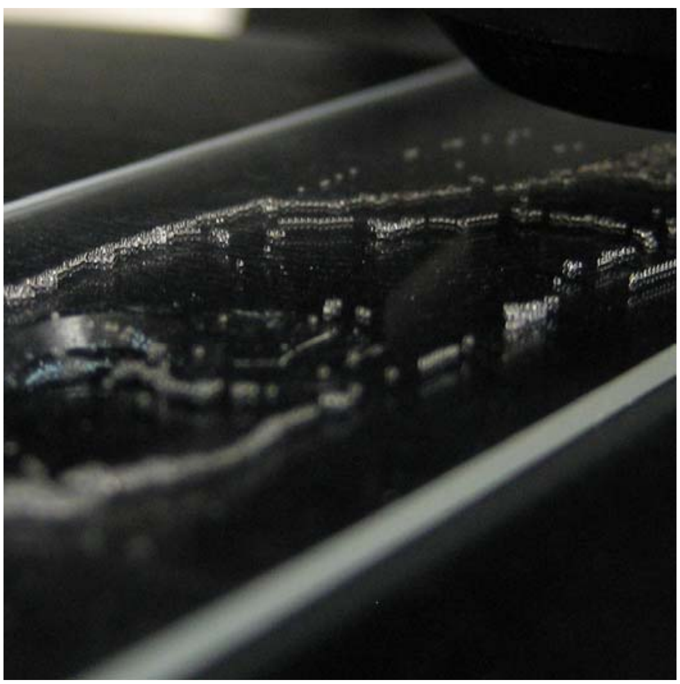
INTRO:

The term Microsphere is widely used in various areas, such as, materials and pharmaceutical sciences, for spherical particles composed of various natural and synthetic materials with diameters in the micrometer range (1µm to 1000µm (1mm)). Microspheres are manufactured in both solid and hollow form and developed in many different materials such as plastic and glass. Hollow microspheres are typically used as additives to lower the density of a material. Solid microspheres have numerous applications depending on what material they are constructed of, and what size they are. Microspheres are a subset of microparticles.

IMPORTANCE OF SURFACE METROLOGY INSPECTION FOR QUALITY CONTROL

Although there are many uses for Microspheres, the use as a bonding mechanism between cells and materials requires critical size and surface roughness control. Size and surface roughness is a vital parameter that influences the Microspheres ability to bond to the intended cell or material. Accurate surface metrology allows for the validation of size and roughness parameters needed to insure the intended bond to a given subject. It is also critical that measurement capabilities allow for the vast collection of materials used in the development of Microspheres. This would include the ability to measure glass and or reflective materials topography.



MEASUREMENT OBJECTIVE

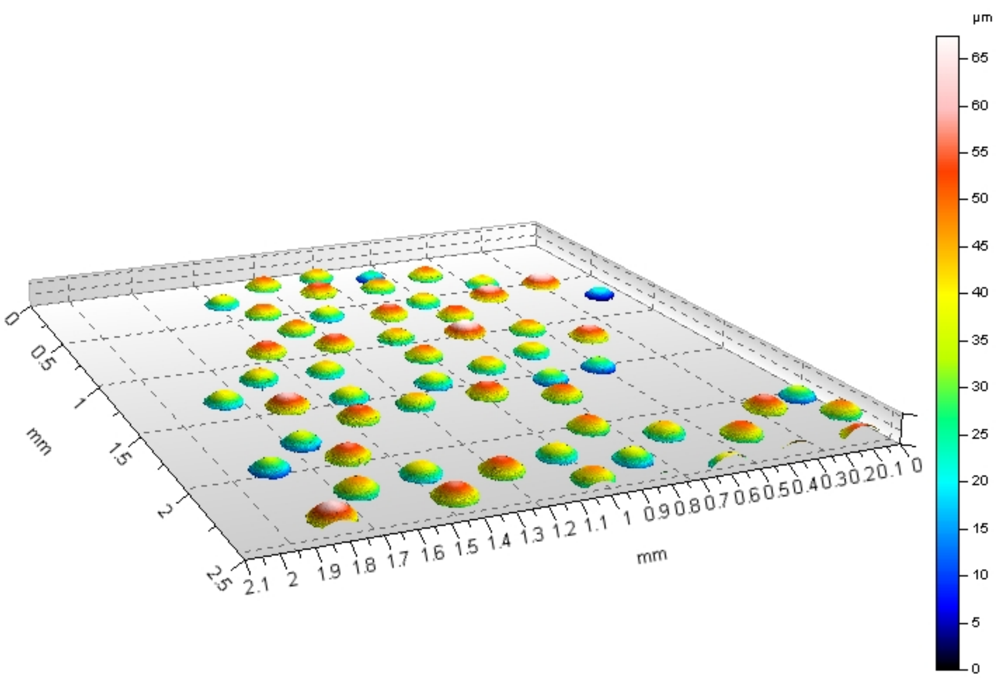
In this application, the Nanovea ST400 is used to measure a small sample of Microspheres to show the consistency of their diameters and the surface roughness of a randomly chosen Microsphere. The diameters were specified as 212µm - 249µm with no surface roughness specification listed. The ST400, along with the camera option, make for a very easy measurement and measurement setup. An additional AFM microscope could be used to further research needs.

MEASUREMENT SET-UP & TIPS:

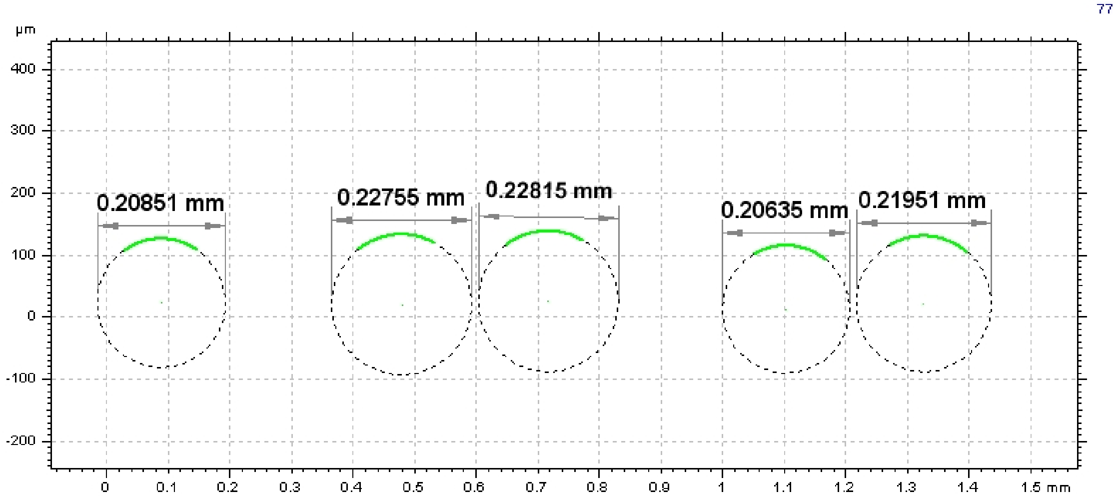
For measuring this type of material, it is best to use a high-intensity Xenon light source. Our optional high-intensity Xenon source produces a very high intensity light, which is extremely useful when measuring a material that is created for light absorption applications.

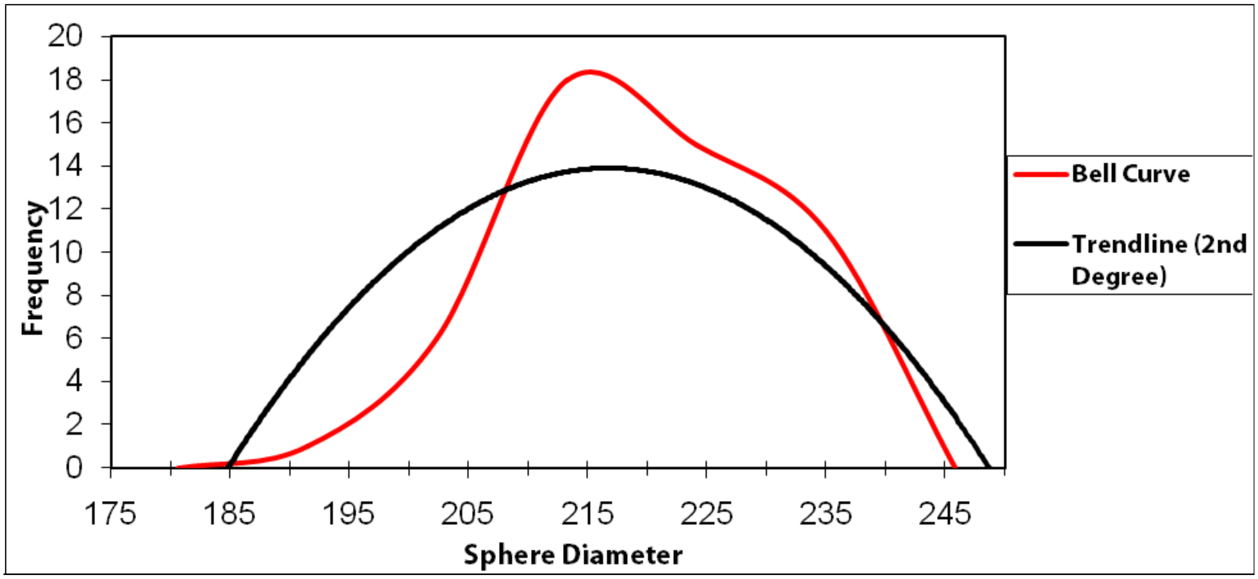
When measuring surface roughness, it is critical to measure with high lateral resolution (very small step sizes between data points). This will produce the most accurate representation of the surface roughness of the solar material.

DISTANCE CALCULATIONS OVER 55 MICROSPHERES:

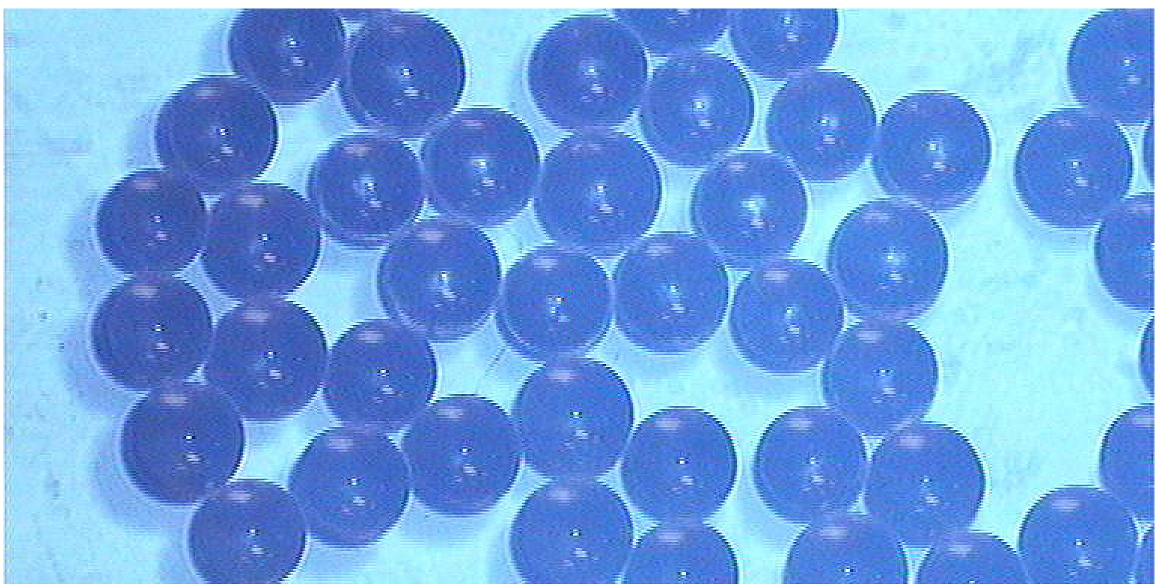


Example of diameter calculation over 5 of the 55 Microspheres

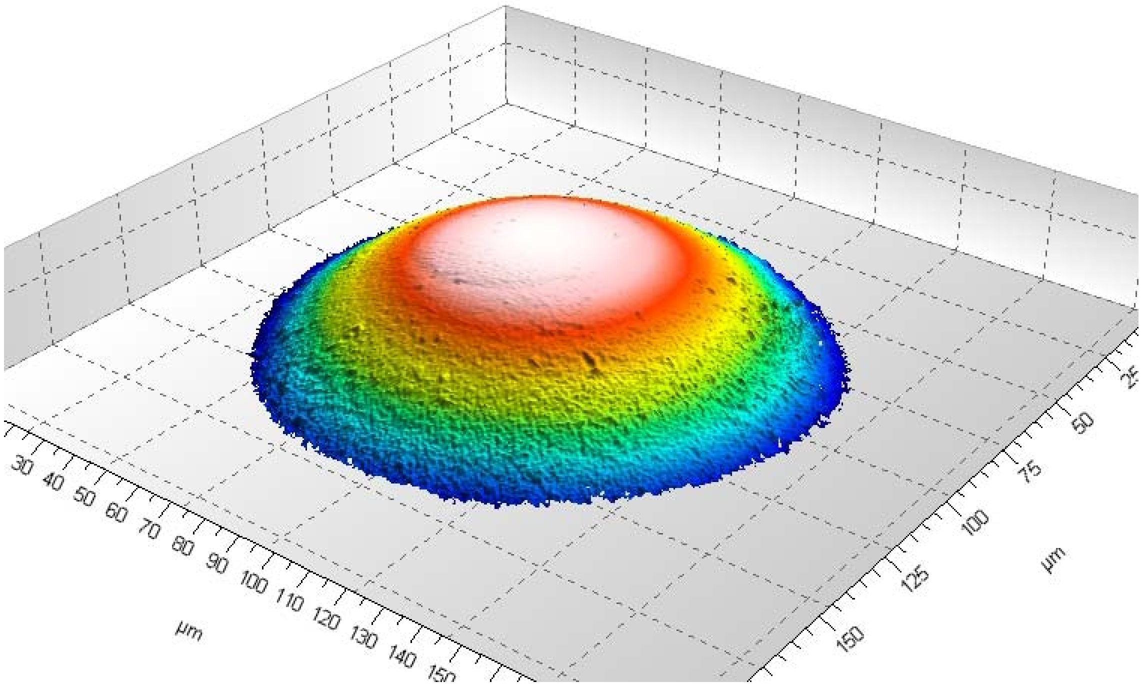




Expected Range: 212µm - 249µm
Measured Mean Diameter = 213.234µm
Measured Minimum Diameter = 228.265µm
Measured Maximum diameter = 185.2804µm



ROUGHNESS MEASUREMENT ON ONE MICORSPHERE:



Surface shape removed and roughness values calculated

SURFACE ROUGHNESS VALUES

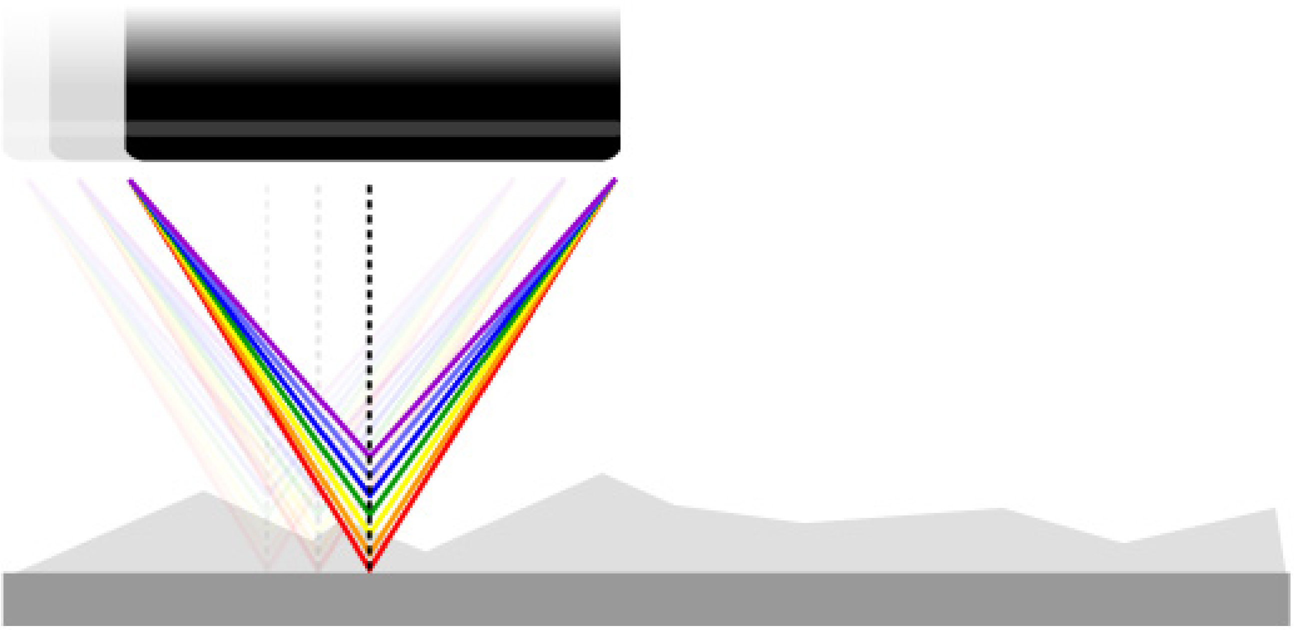
Ssk	Sku	Sq	Sp	Sv	Sz	Sa
0.442	8.486	0.206 µm	2.236 µm	1.501 µm	3.738 µm	0.139 µm

CONCLUSION:

As shown in the above data, is it clear that the ST400 Profiler was able to accurately measure the diameter of the Microspheres. The data also shows that not only was the average diameter much smaller than expected average, but also that there was significant number of these Microspheres that were below the minimum specified values. Although there was no specified value for the surface roughness, the ST400 was able to show an average roughness (Sa) of 139nm. This was calculated first removing the shape of the sphere, then applying the ISO 25178 method for the Sa calculation. Depending on the application the Microsphere will be used for, each of these parameters could be critical, therefore this measurement could be performed to either allow or reject the use of these Microspheres.

MEASUREMENT PRINCIPLE:

The Chromatic Confocal 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.



Unlike the errors caused by probe contact or the manipulative Interferometry technique, Chromatic Confocal technology measures height directly from the detection of the wavelength that hits the surface of the sample in focus. It is a direct measurement with no mathematical software manipulation. This provides unmatched accuracy on the surface measured because a data point is either measured accurately without software interpretation or not at all. The software completes the unmeasured point but the user is fully aware of it and can have confidence that there are no hidden artifacts created by software guessing.

Nanovea optical pens have zero influence from sample reflectivity or absorption. Variations require no sample preparation and have advanced ability to measure high surface angles. Capable of large Z measurement ranges. Measure any material: transparent or opaque, specular or diffusive, polished or rough. Measurement includes: Profile Dimension, Roughness Finish Texture, Shape Form Topography, Flatness Warpage Planarity, Volume Area, Step-Height Depth Thickness and many others.

DEFINITION OF HEIGHT PARAMETERS

	Height Parameter	Definition
Sa	Arithmetical Mean Height	Mean surface roughness. $Sa = \frac{1}{A} \iint_A \lvert z(x,y) \rvert dxdy$
Sq	Root Mean Square Height	Standard deviation of the height distribution, or RMS surface roughness. $Sq = \sqrt{\frac{1}{A} \iint_A z^2(x,y)dxdy}$ 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.
Ssk	Skewness	Skewness of the height distribution. $Ssk = \frac{1}{Sq^3}\left[\frac{1}{A} \iint_A z^3(x,y)dxdy\right]$ Skewness qualifies the symmetry of the height distribution. A negative Ssk indicates that the surface is composed of mainly one plateau and deep and fine valleys. In this case, the distribution is sloping 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 very sensitive to the sampling and noise of the measurement.
Sku	Kurtosis	Kurtosis of the height distribution. $Sku = \frac{1}{Sq^4}\left[\frac{1}{A} \iint_A z^4(x,y)dxdy\right]$ Kurtosis qualifies the flatness of the height distribution. Due to the large exponent used, this parameter is very sensitive to the sampling and noise of the measurement.
Spar	Projected Area	Projected surface area.
Sdar	Developed Area	Developed surface area.