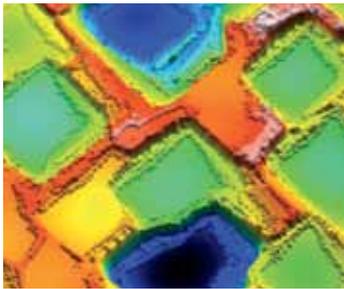


CCI SunStar

Award winning tools for solar cell metrology



The CCI SunStar range

Engineered to challenge your definition of impossible



Optical interferometry without compromise

- 2.2 mm vertical range with closed loop piezoless Z axis scanner
- 0.1 ångström resolution over the entire measurement range
- 2048 x 2048 pixel array for large FOV with high resolution
- 0.3% - 100% reflectivity surfaces measured with ease

Virtual elimination of measurement uncertainty

- <0.2 ångström RMS repeatability, <0.1% step height repeatability
- FEA optimised mechanical design for excellent R&R capability
- Calibration utilising traceability standards ensures acceptance of results
- Automatic set-up features eliminate operator variability

Robust design for long-term cost effectiveness

- Piezoless Z axis scanner eliminates expensive repair bills
- Automatic surface detection prevents crash damage to lens
- Built in self-diagnostic tools for quick and easy troubleshooting
- Ease of operation reduces the possibility of operator mishandling

64-bit control and analysis software

- Multi-language support to ease communication with global partners
- Compatible with most PC platforms for collaborative research projects
- New tools including 4D analysis of 3D surfaces as they evolve over time
- Automatic report generation based on batches of measurement data



“The speed and extraordinary sensitivity makes the CCI SunStar an ideal tool for R&D and quality assurance.”

Prof. Michael Walls, Professor of Photovoltaics at CREST, UK

CCI SunStar is an industry-changing blend of science, experience and imagination

Range, resolution, accuracy, reliability – our formula for your success

However quickly you must analyse it, confidence in your 3D areal measurement result is assured with the revolutionary CCI SunStar non-contact optical profilers. The high resolution camera, combined with 1/10 ångström vertical resolution, delivers an incredibly detailed analysis of all surface types from very rough to extremely smooth.

Versatile – ready for a production run or a research project

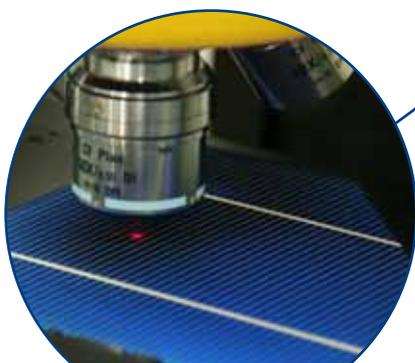
Keeping pace with the expertise of PV researchers and scientists, the CCI SunStar is ready for the demanding measurement requirements of the solar energy field. Combining powerful dimensional and roughness analysis software with uncompromised engineering gives you the ideal inspection tool for step and trench measurement. World-beating thin film thickness measurement capability completes an outstanding metrology package designed for the PV industry.

Ease-of-use – reduces the cost of operator training

Designed for ease-of-use, the CCI SunStar requires no close supervision of operators, making it usable by scientists, students, developers or production inspectors. Its innovative features such as AutoRange and AutoFringeFind simplify setting-up and staging of components, saving valuable time, reducing errors and helping you quickly get the results you need.

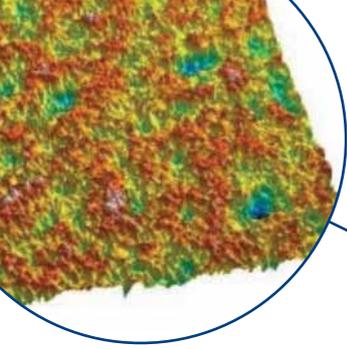
Comprehensive platform – simplifies ISO-17025 integration

Greatly expand your analysis capabilities without increasing the complexity of your analysis program. A broad range of components and surfaces can be measured without the complication of switching between measurement modes or the extra burden of intermediate lens calibration. Standardised methods, procedures and reporting ease the integration of CCI SunStar into your quality management system.



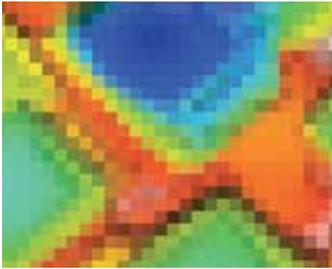
Improving solar cell performance

Unique metrology capability and outstanding software analysis tools make CCI SunStar the optimal PV tool.

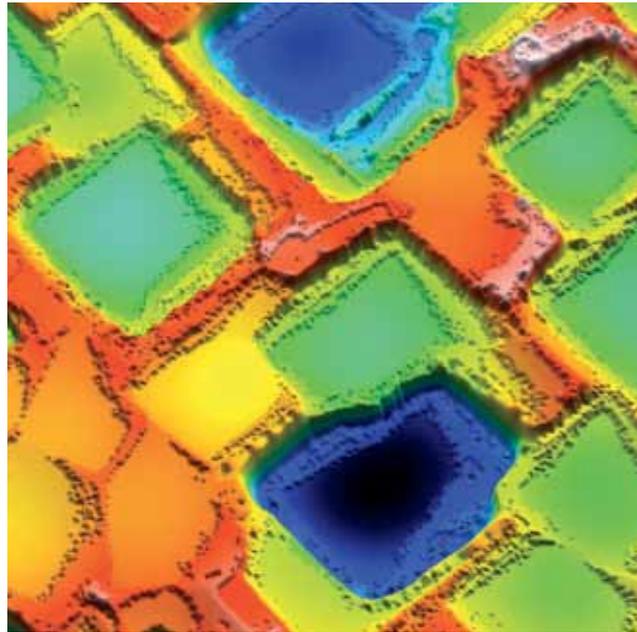


Controlling PV cell efficiency

The complex morphology of etched silicon is easy to understand using a CCI high resolution camera.



Last century 640 x 480



CCI SunStar 2048 x 2048

Next generation 3D camera technology

Higher resolution

CCI SunStar image sensors with up to 2048 x 2048 pixel array are vastly superior to old VGA video camera technology where 640 x 480 pixel array grossly limited lateral resolution. Now you can measure large areas without the complexity or potential distortion caused by field of view multipliers.

Faster measurements

Larger FOV (field of view) means fewer set-ups, faster inspection speeds and better utilisation of equipment and operators. Cost effectiveness is much improved as you can inspect more parts more thoroughly and in greater detail without additional expense.

Superb results

With up to 4 million data points, the measured surface is defined as never before. You can identify surface flaws or potential areas of concern anywhere in the wide FOV and 'zoom in' for detailed analysis without having to waste time re-measuring the component.

NEW camera technology

High resolution visual analysis provides an essential tool for monitoring and improving your manufacturing process. Stunning 3D images with sub-micron detail can also be used to educate, inform or simply impress potential customers with your engineering expertise.

“Innovation in PV technology prize for 2011 has been awarded by SOLAR to Taylor Hobson Ltd for their development of the CCI SunStar.”

21st century optical profiling



Automatic surface detection

AutoFringeFind increases inspection throughput by eliminating manual set-up and the need to re-take measurements caused by false identification of the sample surface. Unlike auto focus routines which require a flat and smooth surface, this innovative coupling of software and optical expertise can detect all types of surfaces quickly and automatically.

Automatic range setting

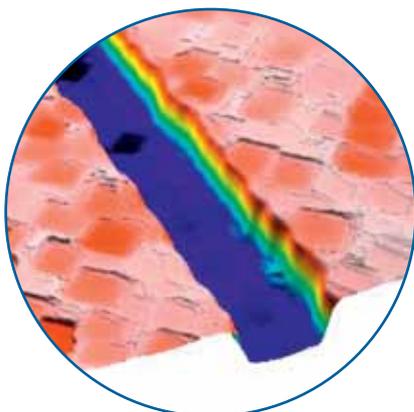
Significant reductions in measurement time are achieved with our exclusive AutoRange feature which automatically sets the optimum scan range based on the sample surface. Manual setting of the scan range is typically a guessing game that often results in over scanning, longer measurement times and frustration for even the most skilled operators.

Universal measurement of different surfaces

Streamline your inspection program by eliminating multiple inspection routines and incompatible measurement reports. Our patented Coherence Correlation algorithm provides sub-angstrom resolution regardless of scanning range so that all surfaces at any stage in production can be measured on the same instrument using the same measuring technique. The algorithm is ideal for looking at very low reflective surfaces such as AR coatings.

Large area high resolution measurement

The field of view optics required by older systems leads to lower lateral resolution and reduced angle sensitivity and the increase in missing data gives poorer surface understanding and therefore less process control. Using the high resolution camera of the CCI SunStar combined with a large area objective is essential for understanding of the surface properties necessary to improve efficiency.



*Enabling high value
low cost PV
Optimising laser scribe parameters
reduces manufacturing cost.*

“Save valuable time, reduce errors and quickly get the results you need.”

Helping to improve the efficiency of solar cells



Step and trench measurements

Optimising the trench depth of the cells is important to minimise expensive silver trace usage. For controlling the trench dimensions the CCI SunStar offers the ability to measure silver trace height and width allowing optimisation of cell efficiency thereby reducing cost. The high measurement speed gives high sample throughput and the optional automation gives the ability to sample multiple sites and/or stitch together large data-sets leading to more representative sampling.

Controlling the parameters of etched scribe lines improves manufacturing efficiency by identifying line depth errors such as shallow lines, which give problems with conductivity, and deep lines which lead to electrical shorts.



Surface roughness

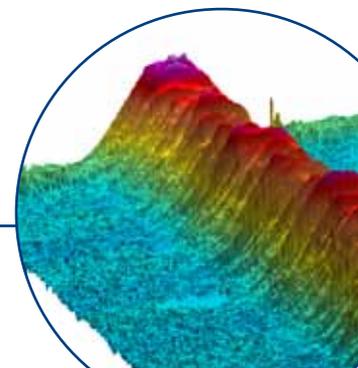
The relationship between the surface roughness and efficiency is complex. Rough surfaces trap more light than smooth surfaces. Surfaces that are too rough reduce the efficiency due to scattering. Other interfaces need to be smooth to reduce scattering and absorption. With the wealth of analysis parameters available in TalyMap you have the ability to choose the parameters that are most relevant to the application, rather than simply relying on traditional parameters like Ra, which do not give information about the features critical for efficiency such as pit dimensions.

Advanced 3D parameters offer correlation. Valleys on the surface help to trap light so parameters such as Ssk show strong correlation with cell efficiency. Other non ISO standard parameters such as Sbi can also be correlated.

CCI SunStar is supplied with customised software interface that includes a comprehensive set of 3D parameters.

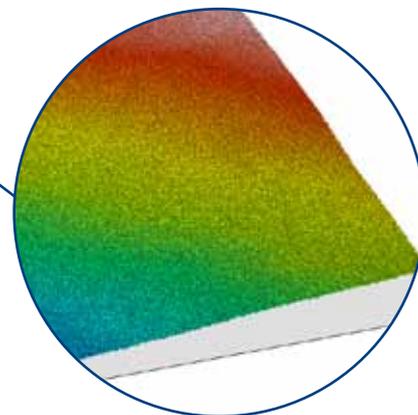
Optimising PV cell efficiency

Uniform trench depth prevents conducting material flowing out of the trench reducing efficiency – CCI SunStar evaluates depth, width, shape, height and volume.



Coating uniformity

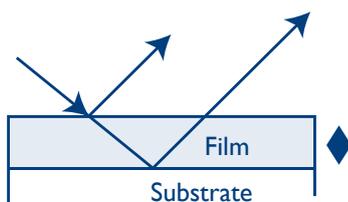
Surface coating quality and uniformity can be improved by measuring the film thickness.



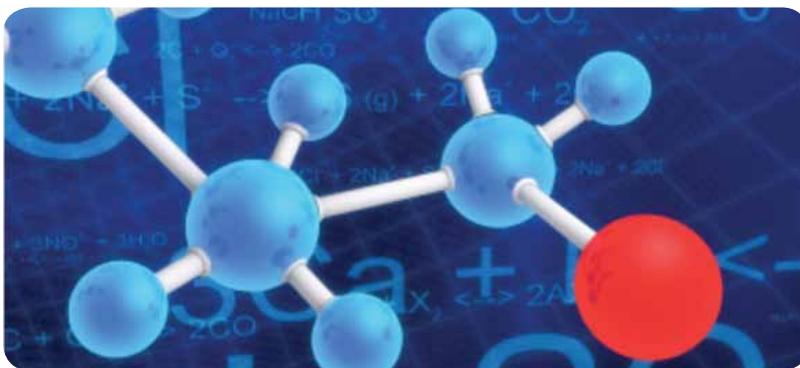
Controlling coating quality

Thick films (>1.5 microns)

- Multi-layer as well as single coatings can be measured
- 3D thickness, thickness uniformity, delamination and interfacial roughness can all be studied in a single measurement
- Automation allows the measurement of multiple sites on one sample and measurement of multiple samples



Film thickness of thin films (>50 nm)



The Helical Complex Field (HCF)* approach, patented by Taylor Hobson, now provides unique measurement capability to measure film thickness below 1.5 micron with unsurpassed vertical and spatial resolution.

Test measurement of SiO₂ thin film on Si

Three samples ranging in thickness from 50 nm to 1000 nm

Sample	# 1	# 2	# 3
CCI (HCF) thickness (nm)	47.3	191.7	1053.4
NIST calibrated thickness (nm)	47.0	191.2	1055.7
Measurement error (%)	0.6	0.3	0.2

Measurement of film thickness down to 25 nm is achievable, dependent upon the optical properties of the film. Information on films less than 50 nm is available on request.

Materials that the CCI can measure include a-Si, CdTe, CdS, CIGS, ITO, ZnO₂, TiO₂, plus many others.

* Mansfield D, 'Thin Film Extraction from Scanning White Light Interferometry', Proc. of the Twenty First Annual ASPE Meeting, Oct 2006

Different CCI SunStar systems for different applications



CCI SunStar SR is supplied with a 1 million pixel camera capable of scan speeds up to 18 microns per second, a motorised software driven stage, 2.2 mm closed loop scan range and AutoRange software functionality.

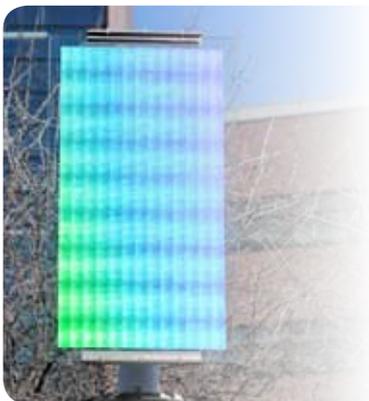
The system is optimised for automatic measurement and analysis of steps and trenches. Optional roughness analysis and a 6-inch sample fixture are available.

Resolution	Software	Scan speed
1M pixels	AutoRange	18 microns / sec

CCI SunStar TF1 has the features offered with the CCI SunStar SR but also includes optional thick film analysis software suitable for multi-layer thickness and roughness of coatings greater than 1.5 microns.



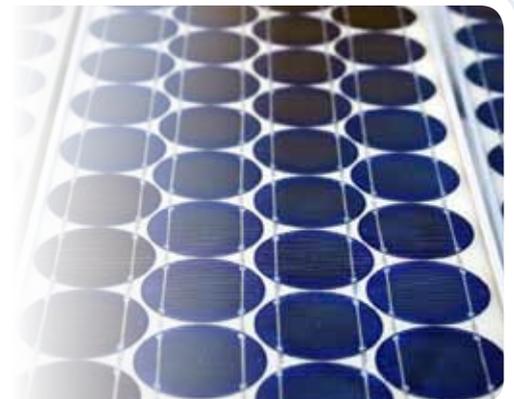
Resolution	Coatings thickness	Scan speed
1M pixels	Down to 1.5 micron	18 microns / sec



CCI SunStar TFE builds on the CCI SunStar TF1 by using a 4 million pixel camera for optimum lateral resolution and extra sensitivity for the measurement of low reflectivity surfaces. The optional film thickness analysis software is ideal for the measurement of single layer thin films down to 50 nm thick, ideal for 2nd generation solar cells.

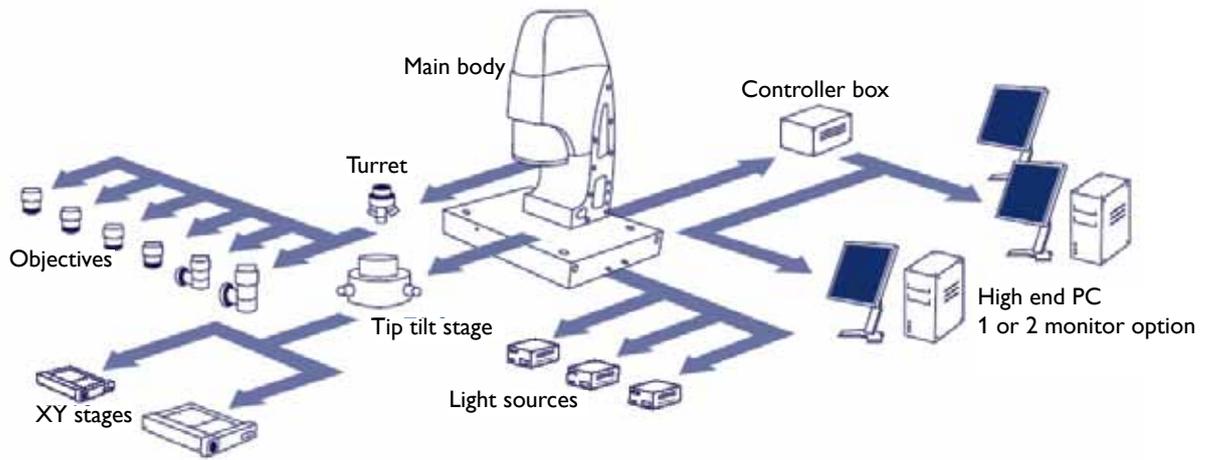
Resolution	Coatings thickness	Low reflectivity
4M pixels	Down to 50 nm	AR coated samples

CCI SunStar RD is designed to meet demanding research and development needs and is the ideal for all solar cell metrology applications, including 3rd and 4th generation. The system comes supplied with automatic measurement, stitching, multi-site and roughness analysis as standard. A 6-inch stage and film thickness analysis software can also be added.



Resolution	Automation	Flexibility
4M pixels	Multi-site measurement	Optimised for research

System Configurations



Specifications are subject to change without notice

	CCI SunStar SR	CCI SunStar TF1	CCI SunStar TFE	CCI SunStar RD
Camera	1M pixel	1M pixel	4M pixel	4M pixel
Step height	✓	✓	✓	✓
Trench width	✓	✓	✓	✓
TalyMap Lite (roughness)	●	●	✓	✗
TalyMap Gold	●	●	●	✗
TalyMap Platinum	●	●	●	✓
Very low reflectivity surface (AR coated)	✗	✗	✓	✓
Thick film analysis (>1.5 μm)	✗	●	●	✓
Film thickness (>50 nm)	✗	✗	●	●
Stitching	●	●	●	✓
Multi-site	●	●	●	✓
Standard lens	20x	20x	10x	10x
Other lenses	●	●	●	●
Joystick	●	●	●	✓
112 x 78 mm stage	✓	✓	✓	✓
156 x 156 mm stage	●	●	●	●
6-inch wafer fixture (156 x 156 mm stage)	●	●	●	●
Internal AV	✓	✓	✓	✓
Active AV	✗	✗	✗	●

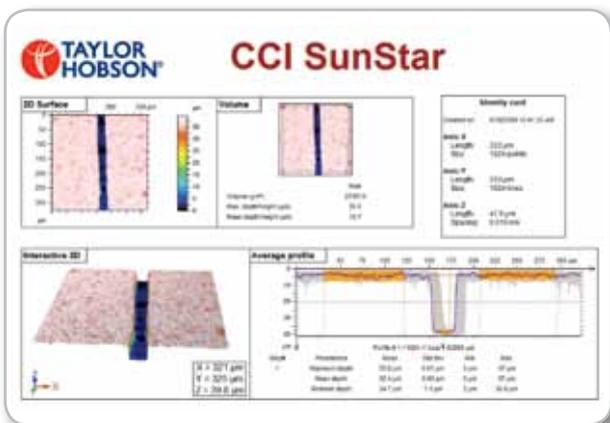
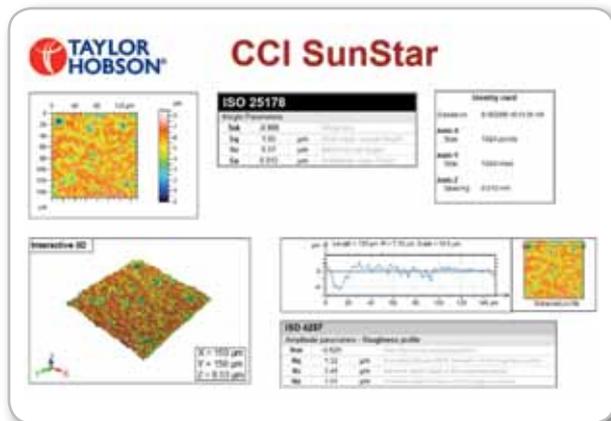
✓ = Included
 ● = Optional
 ✗ = Not available

Powerful software options

Control software specific for solar applications

Now with 64-bit processing, the CCI control software features more flexibility, faster operating speed and improved overall performance. Customised templates specific to solar cell applications make TalyMap software the ideal analysis software platform.

Multi-language support is now available to keep pace with the global economy and international manufacturing partnerships.



TalyMap analysis software

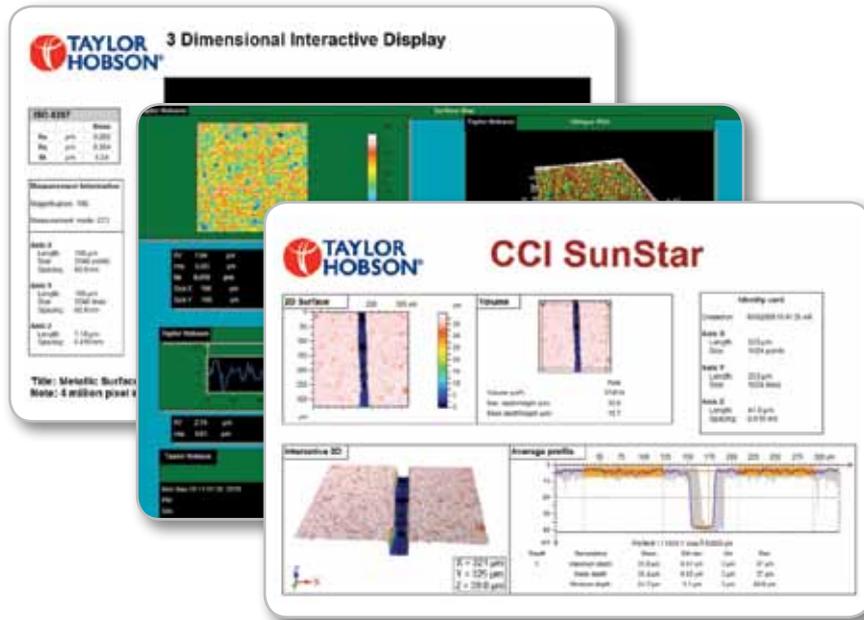
Research facilities, factories and universities worldwide have made TalyMap their preferred surface analysis software. It is used for product development, process improvement, predictive behaviour analysis and routine inspection in many sectors.

TalyMap is continuously evolved by a multi-disciplinary team of specialists in metrology, software engineering and automation in order to meet present and future surface metrology needs.

Key features

- **Full metrological traceability** with a new analysis workflow that makes it easy to trace every step in an analysis document. New steps can be added and existing steps can be fine-tuned or deleted at any time.
- **Statistics for quality control** makes it possible to track and generate statistics on parameters across multiple measurement data sets.
- **Multi-language support** gives options to change the software to work in one of six European languages, Japanese, Chinese, Korean or Brazilian Portuguese.
- **Quick results** achieved from the Minidoc function, where any sequence of analysis steps can be defined and saved into a Minidoc library, significantly speeding up the preparation of new reports.
- **Customisation** allows you to add company logos, measurement identity cards, screen notes and illustrations including bitmaps, text blocks, arrows.
- **Advanced Modules** enhance the functionality of TalyMap by providing additional analysis or presentation capabilities.

Flexible, user-friendly, all-inclusive software



The latest generation of TalyMap software assures conformity with the 3D standard ISO 25178 as well as full metrological traceability. Ideal for research and development products, the latest 2D and 3D parameters will be critical for future developments.

Along with photo-realistic full colour images, TalyMap also includes enhanced productivity tools such as templates for repetitive work and automatic report generation based on batches of measurement data.

Taylor Hobson has a well-deserved reputation for industry-leading data processing. Analysis parameters and software modules available include:

2D parameters	3D parameters
Primary (unfiltered) Pa, Pc, Pdc, Pdq, PHSC, PHtp, Pku, Plo, Plq, Pmr, Pp, Ppc, Pq, Prms, Psk, PSm, Pt, Ptp, Pv, Py, Pz, Pz(JIS), P3z, Pfd, Pda, Pla, PH, PD, PS, Pvo	Amplitude Sa, Sq, Sp, Sv, St, Ssk, Sku, Sz
Waviness (filtered) Wa, Wc, Wdc, Wdq, WHSC*, WHtp, Wku, Wlo, Wlq, Wmr*, Wp, Wpc*, Wq, Wrms, Wsk, WSm, Wt, Wtm, Wtp, Wv, Wy, Wz, Wz(JIS), W3z, Wda, Wla, Wmax, WH, WD, WS, Wvo	Area & volume Stp, SHtp, Smmr, Smvr, Smr, Sdc
Roughness (filtered) Ra, Rc, Rdc, Rdq, RHSC, RHtp, Rku, Rlo, Rlq, Rmr*, Rp, Rpc, Rq, Rrms, Rsk, RSm, Rt, Rtm, Rtp, Rv, Ry, Rz, Rz(JIS), R3z, Rfd, Rda, Rla, Rmax, RH, RD, RS, Rvo	Data analysis Step height, Lateral Distance, Pitch, Angle Measurement, Peak Count, Interactive Abbott-Firestone Curve, Volume of Islands, Fractal Analysis, Motifs Analysis, Frequency Analysis, Data Patching
Rk (DIN 4776, ISO 13565-2) A1, A2, Mr1, Mr2, Rk, Rpk, Rvk, Rpk*, Rvk*	Functional Sk, Spk, Svk, Sr1, Sr2, Sbi, Sci, Svi, Sm, Vv, Vm, Vmp, Vmc, Vvc, Vvv
R&W (ISO 12085) AR, AW, HTrc, Pt, R, Rke, Rpke, Rvke, Rx, Trc, W, Wte, Wx, Kr, Nr, SR, SAR, Kw,	Flatness FLt, FLTp, FLTs, FLTq, FLTv
Autocorrelation, Nw, SW, SAW	Hybrid & spatial Sdq, Ssc, Sdr Spc, Sds, Str, Sal, Std, Sfd
Straightness (ISO 12780) STRt, STRp, STRv, STRq	Filters Gaussian, Robust Gaussian, Spline, Wavelet, Robust Wavelet and Morphological

* All parameters marked with an asterisk are suitable for user-assigned single or multiple qualifiers, e.g., material ratio (mr) may be assessed at one or more slice levels within a single measurement.



Serving a global market

Taylor Hobson is world renowned as a manufacturer of precision measuring instruments used for inspection in research and production facilities. Our equipment performs at nanometric levels of resolution and accuracy.

To complement our precision manufacturing capability we also offer a host of metrology support services to provide our customers with complete solutions to their measuring needs and total confidence in their results.

Contracted Services from Taylor Hobson

- **Inspection services**
measurement of your production parts by skilled technicians using industry leading instruments in accord with ISO standards
- **Metrology training**
practical, hands-on training courses for roundness and surface finish conducted by experienced metrologists
- **Operator training**
on-site instruction will lead to greater proficiency and higher productivity
- **UKAS Calibration and Testing**
certification for artifacts or instruments in our laboratory or at customer's site

For the above services, contact our Center of Excellence:
email: taylor-hobson.cofe@ametek.com
or call: **+44 116 276 3779**

- **Design engineering**
special purpose, dedicated metrology systems for demanding applications
- **Precision manufacturing**
contract machining services for high precision applications and industries
- **Preventative maintenance**
protect your metrology investment with a Tallycare service cover plan

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