PGI Dimension – Hemispheres

Unique measurement capability for steep-sided small hemispheres

Lucy Cooper, Applications Engineer

"Taylor Hobson has designed the PGI Dimension to meet the ever-increasing demands of modern optics applications."

Bob Bennett, Technical Director, Taylor Hobson Ltd.

Introduction

In order to have confidence in a measurement process, it is essential to achieve results which are highly repeatable and also traceable to international standards.

In this Application Note, a traceable calibrated standard is measured on Taylor Hobson's PGI Dimension in order to demonstrate system accuracy, repeatability and the capability of measuring up to 85 degrees slope.

We also identify some of the measurement challenges faced when measuring steep sided samples on a profilometer and explain how Taylor Hobson's PGI Dimension addresses these and provides high quality multi-profile data.

Challenges

Small diameter optics are amongst the most demanding of today's ultra-high precision form and radius measurement applications. They present a number of challenges in obtaining highly accurate and repeatable data. A traceable hemispherical standard is an excellent way of proving the process capability.

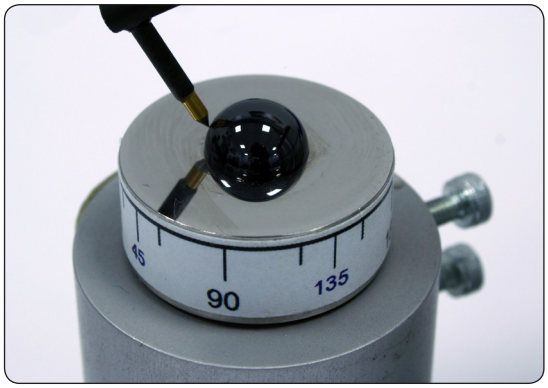

Figure 1: METAS Certificate of Calibration No 115-01452. Mean Diameter – 9.525453 mm

The main challenges are:

Sample has steep sides – There are two fundamental issues here, the first is to avoid any stylus flanking at all as this totally invalidates the data set.

Secondly, even if flanking is overcome by a special stylus, many measurement systems will show a progressive deterioration in data quality as the slope gets steeper.

Alignment – The measuring instrument needs an alignment capability that ensures that each measurement is taken right over the sample centre. Simply measuring over an ill-defined turning point may yield poor results. The sample must be well aligned to the instrument's rotational axis. This is particularly important if profiles are taken at different angular positions are taken. A measurement taken off axis may result in significant measurement errors. It is therefore critical that the instrument alignment process is repeatable and well defined and that the instrument has high inherent accuracy and stability. The smaller the sample and the steeper the sides the more critical this becomes.

Measurement repeatability – As discussed, reliable sample alignment is necessary before repeatable measurements can be made. As we are dealing with small samples and low tolerances this presents a significant challenge and requires the measurement system be highly capable and highly stable. Instrument set up, environment and alignment are very important factors.

PGI Dimension – The solution

High quality data on steep sides – By tilting the traverse datum, the PGI Dimension prevents stylus flanking and eliminates the effect of the steep sides

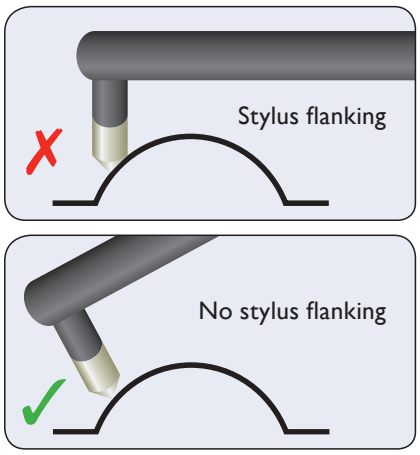

Figure 2: Angled gauge head resolves flanking issue

High precision alignment – Before the start of the measurement, the sample is aligned using Taylor Hobson's patented 'auto centre' technique to align the sample to the instrument rotational axis.

Excellent repeatability – PGI Dimension provides superb repeatable results thanks to Taylor Hobson's own highly stable precision measurement datums on a measurement platform which incorporates active anti-vibration.

Measurement results

A total of 10 measurements were taken at the same angular position on a small hemisphere sample in order to show typical form repeatability.

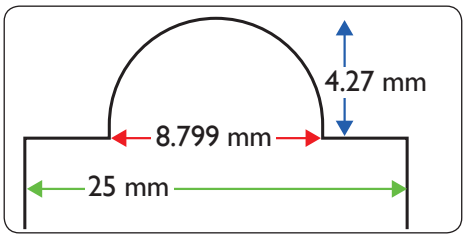

Figure 3: Clear aperture and sag

Repeatability on steep slopes (83°)

The 10 measurements were compared for repeatability. This is shown in the graph below. The Ls filter used was 0.025 mm. The table below shows the Pt value from the ten measurements.

Certified radius 4.76273 mm

Measurement	1	2	3	4	5	6	7	8	9	10	Max-Min
Form error (Pt) nm	64	62	55	55	59	55	60	57	60	58	9
Opt. Base Rad. mm	4.76280	4.76278	4.76282	4.76281	4.76284	4.76287	4.76287	4.76287	4.76286	4.76287	90 nm

Table 1: Form error (Pt) and optimised base radius (mm) results (0–180 deg)

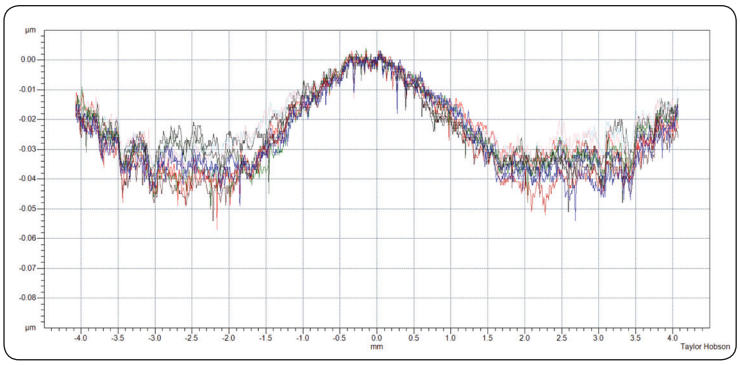

Figure 4: Repeatability measurements

Conclusion

The PGI Dimension provides a highly stable measurement platform, ideally suited for the measurement of steep-sided small hemispheres. The results show excellent radius traceability and form error repeatability. It ensures that the sample axis is correctly centred to the instrument rotational axis and eliminates the data distortion normally seen when profilometers measure steep sides. Its excellent repeatability makes it the perfect instrument for production process control.

Taylor Hobson UK
(Global Headquarters)
PO Box 36, 2 New Star Road
Leicester, LE4 9JD, England
Tel: +44 116 276 3771
taylor-hobson.sales@ametek.com

Taylor Hobson France
Tel: +33 130 68 89 30
taylor-hobson.france@ametek.com

Taylor Hobson Germany
Tel: +49 611 973040
taylor-hobson.germany@ametek.com

Taylor Hobson India
Tel: +91 80 67823200
taylor-hobson.india@ametek.com

Taylor Hobson Italy
Tel: +39 02 946 93401
taylor-hobson.italy@ametek.com

Taylor Hobson Japan
Tel: +81 36809 2406
taylor-hobson.japan@ametek.com

Taylor Hobson Korea
Tel: +82 31 888 5255
taylor-hobson.korea@ametek.com

Taylor Hobson China Beijing Office
Tel: +86 10 8526 2111
taylor-hobson.beijing@ametek.com

Taylor Hobson China Shanghai Office
Tel: +86 21 58685111-110
taylor-hobson.shanghai@ametek.com

Taylor Hobson Singapore
Tel: +65 6484 2388 Ext 120
taylor-hobson.singapore@ametek.com

Taylor Hobson USA
Tel: +1 630 621 3099
taylor-hobson.usa@ametek.com