Form Talysurf® PGI **NOVUS** and **Metrology 4.0** software

Fuel cell measurement

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Fuel cells

Fuel cells are devices that convert chemical energy (usually Hydrogen) directly into electrical energy, water and heat.

A fuel cell combined with a motor replace the need for an engine. Hydrogen fuel cell technology is becoming increasingly important in the automotive industry. A reason for this is that hydrogen powered fuel cell vehicles are classed as ultra-low emission vehicles. In this Application Note, we demonstrate the ability to measure the multiple steep sided grooves which affect gas diffusion and Fuel Cell performance. (See Figure 1).

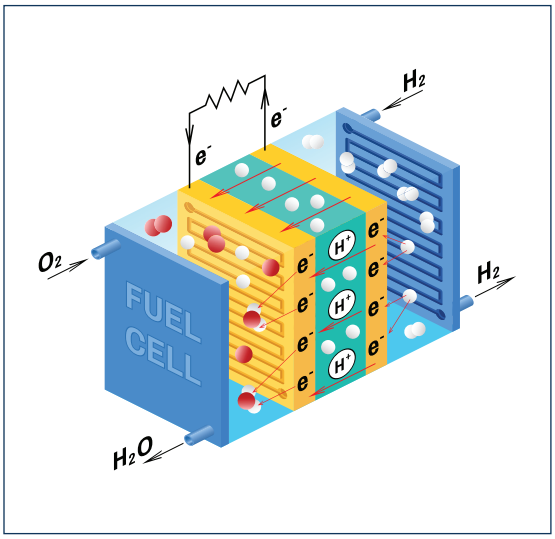

Figure 1 - Diagram illustrating the function of a fuel cell

Challenges in measuring fuel cells

1. Steep sides

The biggest difficulty in measuring a fuel cell is being able to measure the grooves along the surface. These can have very steep (~75°) surfaces and cannot be measured with a single trace using a profilometer (see Figure 2).

Typical stylus tips have an included angle of 60° which limits the valid measurement to an angle of ~45°. Measurement solutions need to provide valid data along the length of the groove.

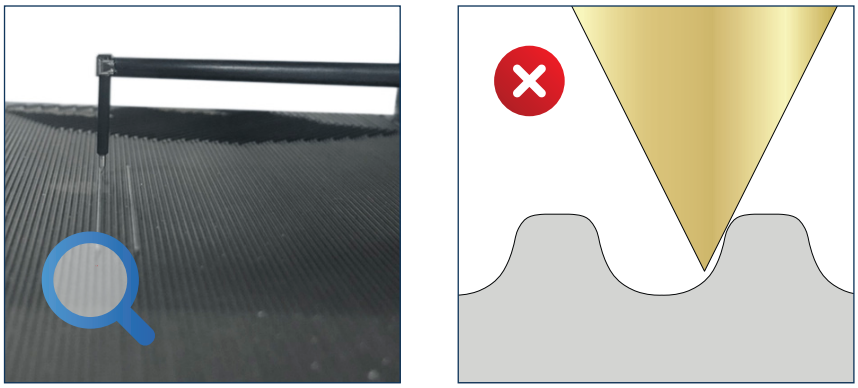

Figure 2 - The typical groove pattern on a fuel cell and how a conventional measurement will cause stylus flanking.

2. Component alignment

For any measurement, to accurately capture the true profile of the groove, the component must be well aligned to the measurement axis. If there is any misalignment of the fuel cell, then the true profile of the groove will be missed. To aid accuracy and speed up the measurement cycle time, the alignment process should be fully automatic.

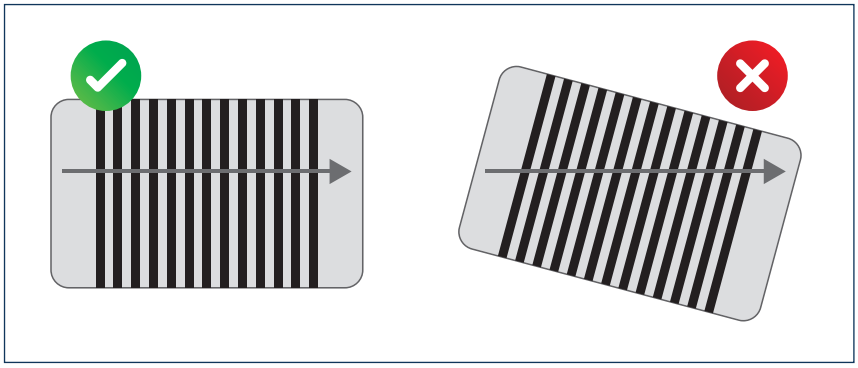

Figure 3 - Correct alignment configuration for the measurement of a fuel cell.

Solutions provided by Form Talysurf® PGI NOVUS and Metrology 4.0

1. Steep sides

Form Talysurf® PGI NOVUS and Metrology 4.0 provide a convenient way to measure the steep sided groove profiles on a fuel cell. This is done by using traverse unit tilt which enables the component to lie flat on the measurement stage and the traverse unit to be angled to allow for a steep-sided measurement. The traverse unit can be inclined to an angle of up to 30° and has been designed to be fit for use with a wide variety of fuel cell designs.

In the example below, the fuel cell surfaces have an angle of up to 75°. The measurement solution requires 3 profiles to be taken. The first will be with the traverse unit horizontal, capturing the flat regions of the profiles (see Figure 4a and 5a). Once this measurement has been completed, the traverse unit is inclined to an angle of 30° and a trace is taken over the same area of the component (see Figure 4b and 5b). The final step in the procedure is to rotate the sample by 180° and measure again, this will get the remaining bit of data that is required to complete the profile (see Figure 4c and 5c).

Using automatic stages in conjunction with the Metrology 4.0 coordinate system, the instrument can work out where to position the stylus on the surface of the fuel cell. This method of fuel cell measurement increases accuracy as the component is not touched by the operator.

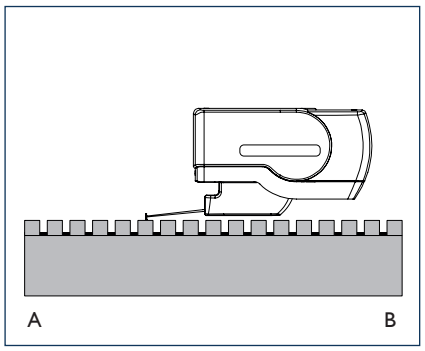

Figure 4a - Horizontal measurement taken in the $\xrightarrow[AB]{}$ direction

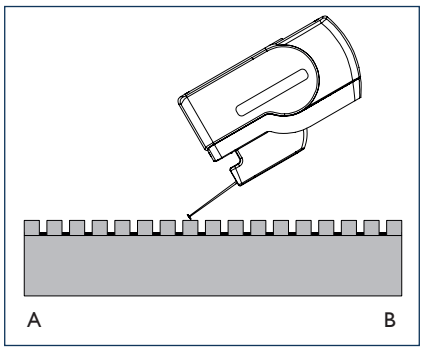

Figure 4b - Tilted measurement taken in the $\xrightarrow[AB]{}$ direction

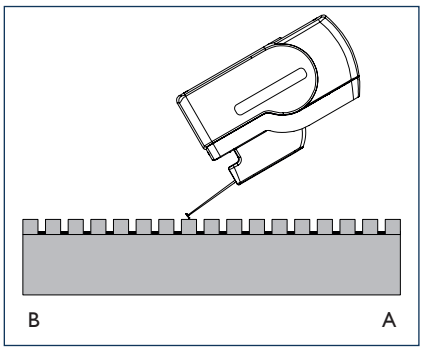

Figure 4c - Tilted measurement taken in the $\xrightarrow[BA]{}$ direction

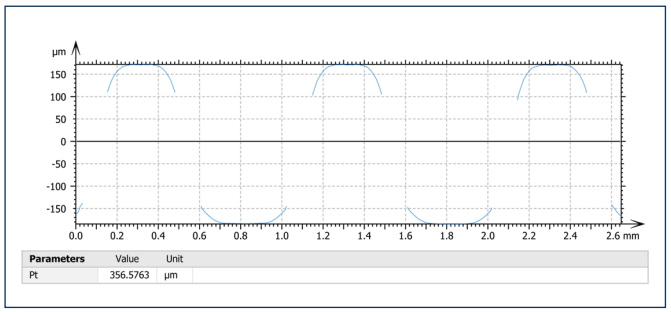

Figure 5a - The Horizontal measurement is used to obtain the flat portions of the profile

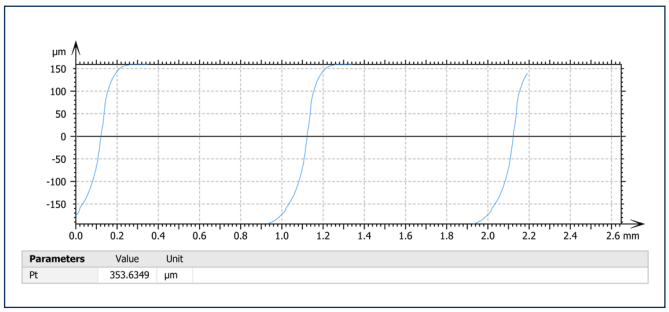

Figure 5b - The tilted measurement is done to get the right-hand side portions of the groove profile

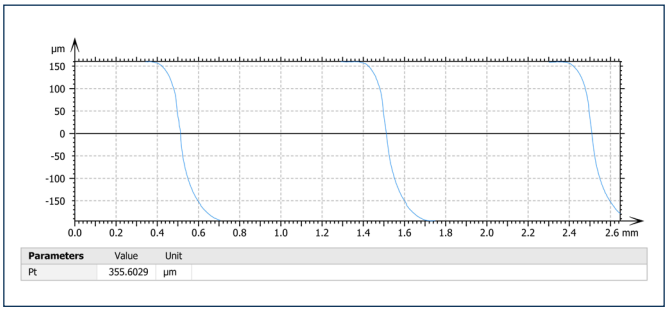

Figure 5c - The part is then rotated by 180° and the second tilted measurement is done to get the left-hand side portions of the steep groove profile

Once these measurements have been completed, Metrology 4.0 analysis is utilised to fuse the profiles together with the use of the new data fusion software. This powerful tool is fully automatic and disregards any invalid data that is caused by stylus flanking.

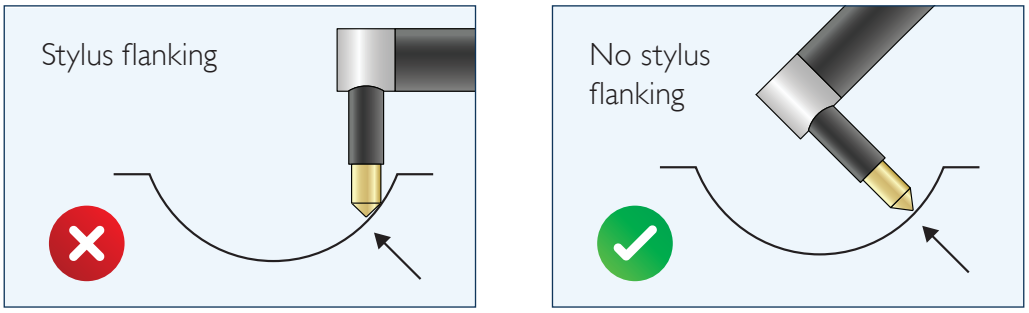

Figure 6 -The tilted traverse unit resolves the flanking issue on steep surfaces.

Profile data fusing utility

Metrology 4.0's data fusion software is the automatic solution for accurate profile fusing.

In 3 easy steps the automatic fusing is completed:

1. 2 profiles are selected.
2. The profiles are automatically aligned to one another using the valid portions of the measurement.
3. The resulting profile is displayed.

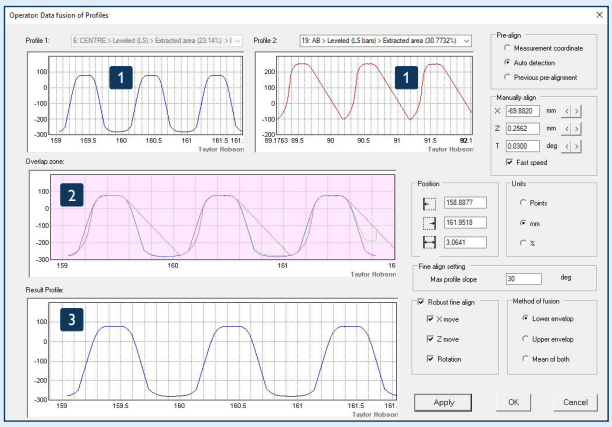

Figure 7 - Data fusion utility that is designed to be user friendly and practical

2. Component alignment

It is important to capture the true profile of the groove profile. To ensure this, the component should be correctly aligned to the instrument axis. This is particularly important for when small radii are involved. The system achieves this rapidly by use of high accuracy (Y and rotary) stages with an automated alignment routine. The Y-stage and rotary stage are used to determine the reference edges at each end of the fuel cell and rotate it by the correct amount. This increases accuracy, repeatability, reproducibility and throughput as there is no operator interaction required.

Accurate fuel cell measurements can only be achieved following correct alignment.

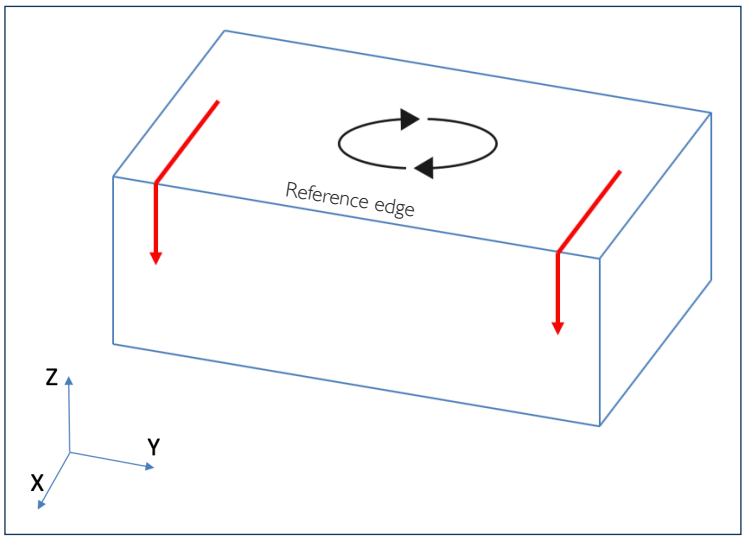

Figure 8 - Alignment measurement process

Results

Metrology 4.0 analysis and contour software can accurately analyse the complete fuel cell groove. Analysis including form, radius, dimensions, angles and much more can be displayed automatically inside of a measurement program. The layout of the analysis is completely user-specific.

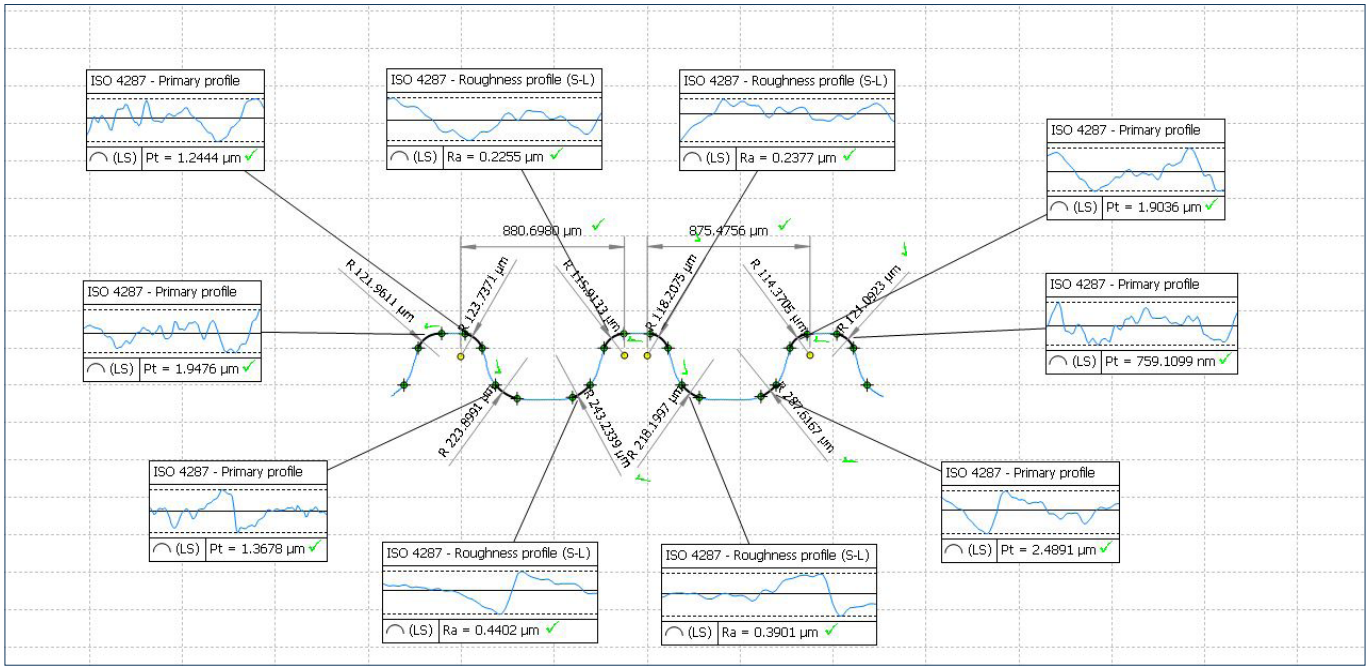

Figure 9 - Full fuel cell analysis including: form, radius, dimensions and angles

Summary

Form Talysurf® PGI NOVUS and Metrology 4.0 software provide the definitive solution for fuel cell steep-sided groove measurement. Taylor Hobson have met the key requirements needed to measure the component accurately and efficiently. The key challenges for fuel cell groove measurement are fully met through unique and innovative hardware and software capabilities.

Stylus flanking is eliminated by use of the Form Talysurf® PGI NOVUS tilted traverse and Metrology 4.0's unique Data Fusion software. Together, these maintain the data integrity of the measurement and provide a true representation of the groove profile. Results can be displayed inside of a measurement program. The whole process is fully automatic.

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