Renishaw plc
New Mills, Wotton-under-Edge,
Gloucestershire, GL12 8JR
United Kingdom

T +44 (0)1453 524524
F +44 (0)1453 524901
E uk@renishaw.com
www.renishaw.com

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Information sheet
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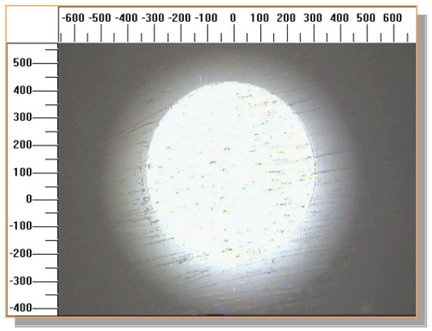
Effects of continuous scanning on stylus balls

Phenomenon 3 - abrasive wear

Abrasive wear involves removal of material from both surfaces where:

- small particles from both surfaces break and adhere to each surface;
- harder stylus particles attached to the component surface begin to act as an abrasive;
- there is little atomic attraction between the two materials and wear rather than material build up occurs.



Test conditions:
- Silicon nitride on stainless steel.
- 50 g contact force, single point contact.
- 1,800 m scan path over new material.
- Very extreme - unrepresentative of most applications.

Results:
- Flat on ball surface approx. 700 µm diameter.
- Form error of 0.25 µm on 5 mm dia ball.

Ball material - conclusions from testing at Renishaw

- **Ruby** can suffer adhesive wear (pick-up) on aluminium under extreme conditions, but performs well in most applications.
- **Ruby** is the best material on stainless steel and titanium.
- **Silicon nitride** is a good substitute for ruby in extreme aluminium applications, but suffers from abrasive wear on stainless steel and cast iron.
- **Zirconia** is the optimum choice for scanning cast iron components.
- **Tungsten carbide** also performs well on cast iron.

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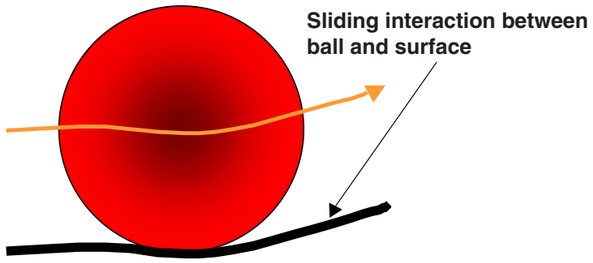
Three phenomena that can affect scanning accuracy:

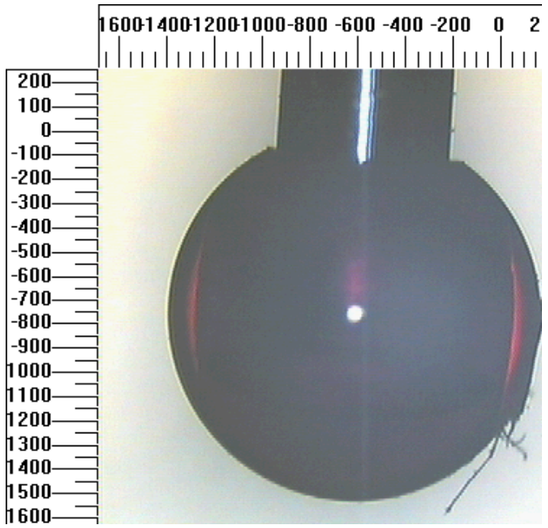
When touch trigger probing, the stylus ball comes into temporary contact with the surface to be measured. Scanning with a stylus in continuous contact with the surface results in a different and more aggressive type of surface interaction. Testing at Renishaw has revealed three interactive phenomena:

1. Debris.
2. Adhesive wear.
3. Abrasive wear.



Phenomenon 1 - debris

Any contamination present on the scanning path will collect on the stylus ball as it passes over the surface. Contamination may include metal oxide particles on the surface and air-born debris such as coolant mist or paper dust. Debris can be removed by wiping the ball with a dry, lint-free cloth and a periodic cleaning regime can help avoid a build up of contamination. Debris is practically unavoidable with any contact scanning application and is independent of the stylus ball or scanned surface material.



Typical debris collected on a stylus ball after scanning

Point	Elements
1	C, O, Na, Al, Si, P, Cl, K, Ca, Cr
2	C, O, Al, Si, S, Cl, K, Ca, Cr
3	C, O, Al, Si, S, Cl, Ca, Cr
4	C, O, Na, Al, Si, P, S, Cl, K, Ca, Cr
5	C, O, Al, Si, S, Cl, K, Ca, Cr
6	C, O, Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, Cr, Fe, Zn
7	C, O, Al, Si, S, Cl, K, Ca, Cr, Fe
8	C, O, Al, Si, S, Cl, K, Ca, Cr
9	O, Al, Cr

Secondary Electron (SE) image analysis of typical debris

Phenomenon 2 - adhesive wear

Adhesive wear (sometimes referred to as pick-up) involves the transfer of material from one surface to another through the process of:

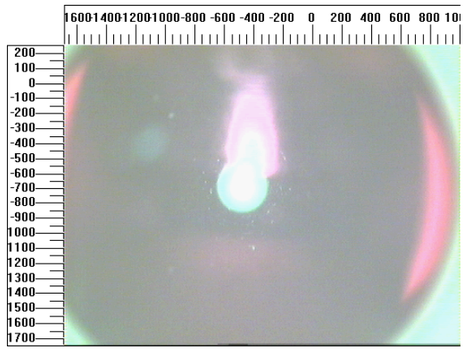
- local welding (adhesion) at microscopic contact points;
- break off during sliding;
- minute particles from one surface are transferred to the other surface.

Material adhesion is permanent and cannot be removed through normal cleaning techniques. Thus, as the surface material from the workpiece adheres to the ball and contacts with the surface, like materials attract and build up can occur. Such build up will eventually degrade the form of the stylus ball and compromise any measuring results. Factors affecting adhesive wear include:

- contact force;
- distance scanned;
- hardness of surfaces (if stylus is much harder than surface being measured);
- affinity between ball and surface materials … is it a similar material?;
- single point contact.

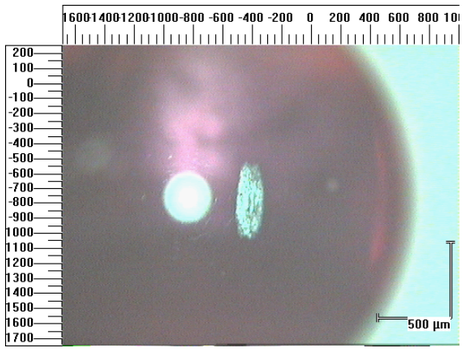
Such conditions apply when scanning an aluminium surface with a relatively hard ruby (aluminium oxide) stylus ball:

- significant wear only occurs after long periods scanning the same part;
- in most real applications, the amount of material transfer is negligible on the form of the stylus ball (< 0.1 µm) and cannot be quantified, even with the highest precision measuring equipment;
- significant errors only occur in unrepresentative situations.



Test conditions:
- ruby stylus on aluminium;
- 15 g contact force, single point contact;
- 350 m scan path over **new material**.

Results:
- small patch where adhesion occurs;
- negligible impact on ball form.



Test conditions:
- ruby stylus on aluminium;
- 15 g contact force, single point contact;
- 350 m scan path over **repeated path**.

Results:
- 200 µm x 500 m adhesion patch;
- 2 µm impact on ball form.