Ingram Tribology

Subsurface analysis case study

Background

When metal parts fail due to pitting, the pit can be either surface or subsurface initiated.

Subsurface initiated pits are where the cracks start below the surface.

White etching cracks is a type of subsurface fatigue failure where multiple networks of cracks are formed below the surface of the steel. These result in many pits and axial cracks being formed and failure of the component.

The mechanisms of how these cracks form is still under debate in the academic community but probably requires some kind of accelerant. The accelerants that are known to form WECs are bad reference oils, electrical currents, high loads and hydrogen charging.

Challenge

The client was conducted testing lubricants on an EV transmission. One that could potentially have the WEC failure on the bearings.

After the EV transmission had been through its normal testing. The transmission was disassembled and sent to us for a thorough analysis.

We disassembled all the bearings and analysed their surface for any signs of pits or cracks.

We then conducted a thorough subsurface analysis, by selecting any areas of concern and a statistical selection of random bearing parts. We then cut the parts to sample sizes, ready for mounting in resin pucks. This then allowed us to conduct a thorough subsurface analysis of bearing parts – looking for subsurface features such as butterflies, inclusions, and crack network.

This gave the client confidence that they were able to prevent the formation of the white etching cracks in the transmission – that they weren't lurking undetected, only for the part to fail when it reached service.

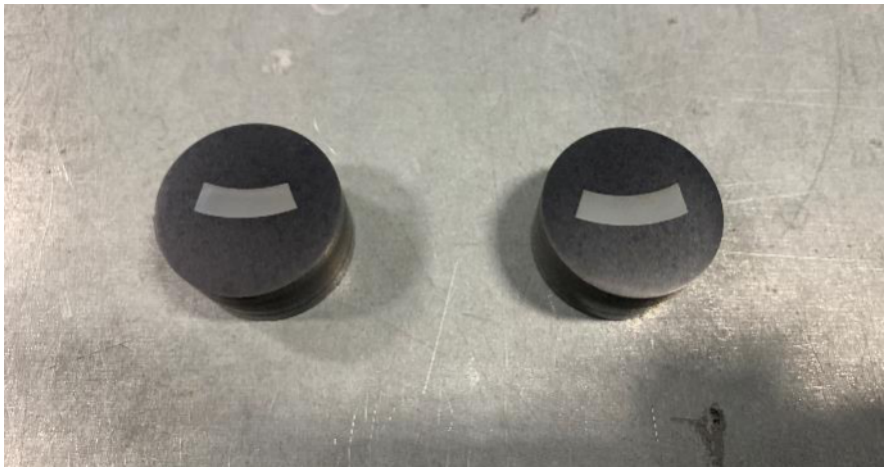

Figure 2 Bearing inner raceway, mounted ready in a resin puck.

Figure 1 Examples of a subsurface image of the material below the surface of the bearing raceway.

Some of the gear teeth were also analysed using this technique.

This is used to ensure no subsurface cracks are present in the gear teeth. It is also used to see the wear and micro pitting on the gear teeth and how this wear has affected the gear teeth form.

Figure 3 A transmission gear with a selection of teeth removed by a EDM process.

A single gear tooth, after removal, ready for mounting and subsurface analysis.

Two gear teeth mounted ready for analysis

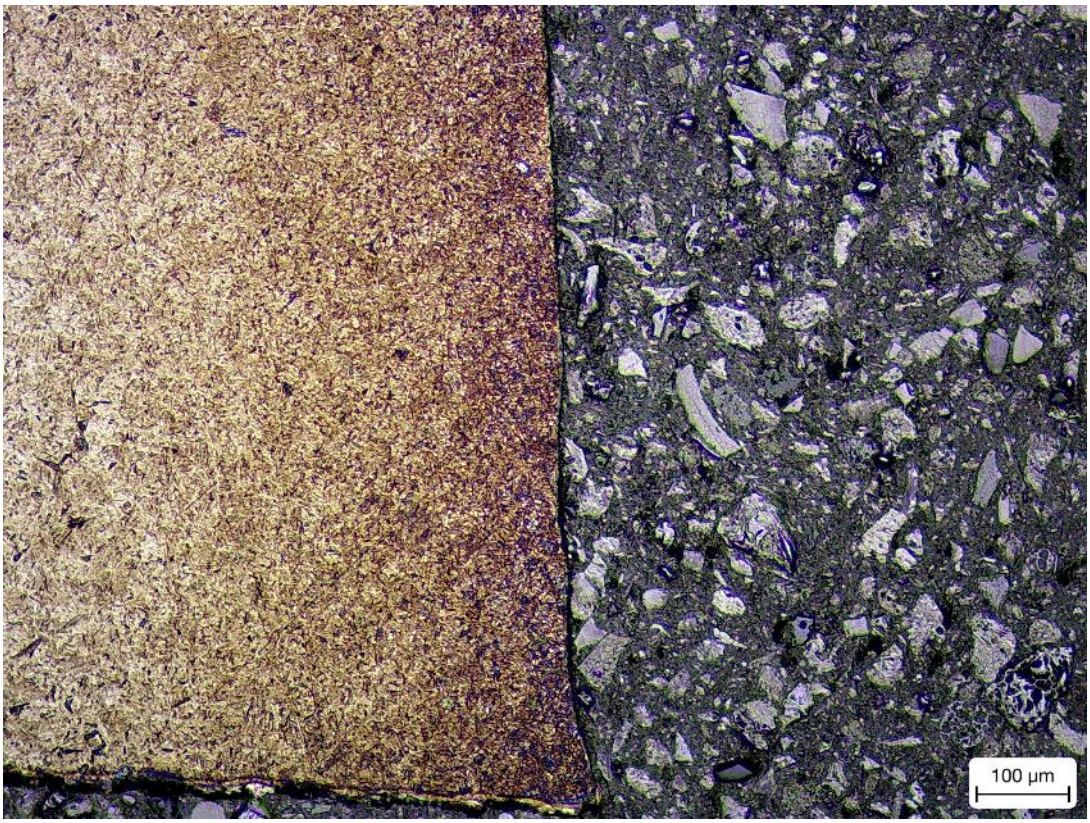

Figure 4 An example of a section of a gear tooth. Showing the wear of the gear dedendum.