

STRESSTECH BULLETIN 3

Detection Methods of Grinding Damages

Combined with dimensional inspection, hardness tests and periodic metallographic analysis, the Barkhausen noise analysis method can help close the loop on insuring product quality.

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Traditional methods for detecting grinding related damages include visual inspection by nital etching, micro-hardness testing, and residual stress profiling with X-ray diffraction (XRD). However, these methods have always had one or more drawbacks, such as cost, time, complexity, subjectivity, or the use of hazardous chemicals.

Comparison of the Grinding Damage Detection Methods

Property	Barkhausen noise	Nital Etch	Micro-hardness	XRD
Nondestructive	Yes	No*	No	Yes (No**)
Use of Chemicals	No	Yes	No	No (Yes**)
Automated	Yes	No	No	No
Reliable	Yes	No	No	Yes
Evaluation Through Coatings	Yes	No	No	No (Yes***)
Danger of Hydrogen Embrittlement	No	Yes	No	No
Influenced by Both Stress and Microstructure	Yes	No	No	Yes
Time Consuming	No	Yes	Yes	Yes

* In many industries, it is not possible to use the component after it is nital etched.

** When stress depth profile is required, material removal by electropolishing (chemical etching) is necessary.

*** It depends on the thickness and material of the coating.

The nital etching and micro-hardness methods can only detect severe grinding damages. Furthermore, both methods have the same challenges: traceability and repeatability.

XRD method can also be used to detect the grinding damages. However, it is time consuming, expensive, and destructive when subsurface stresses need to be analysed.

It is also important to emphasize that what we call a grinding damage or a “grinding burn” is a thermo-mechanical defect in which both thermal and mechanical loads play active roles.

It is a tribology phenomenon. Even at a lower temperature, there could be dramatic residual stress

changes. This is due to the mechanical load from the grinding wheel on the contact area. These changes in stresses cannot be detected non-destructively with any of the traditional methods.

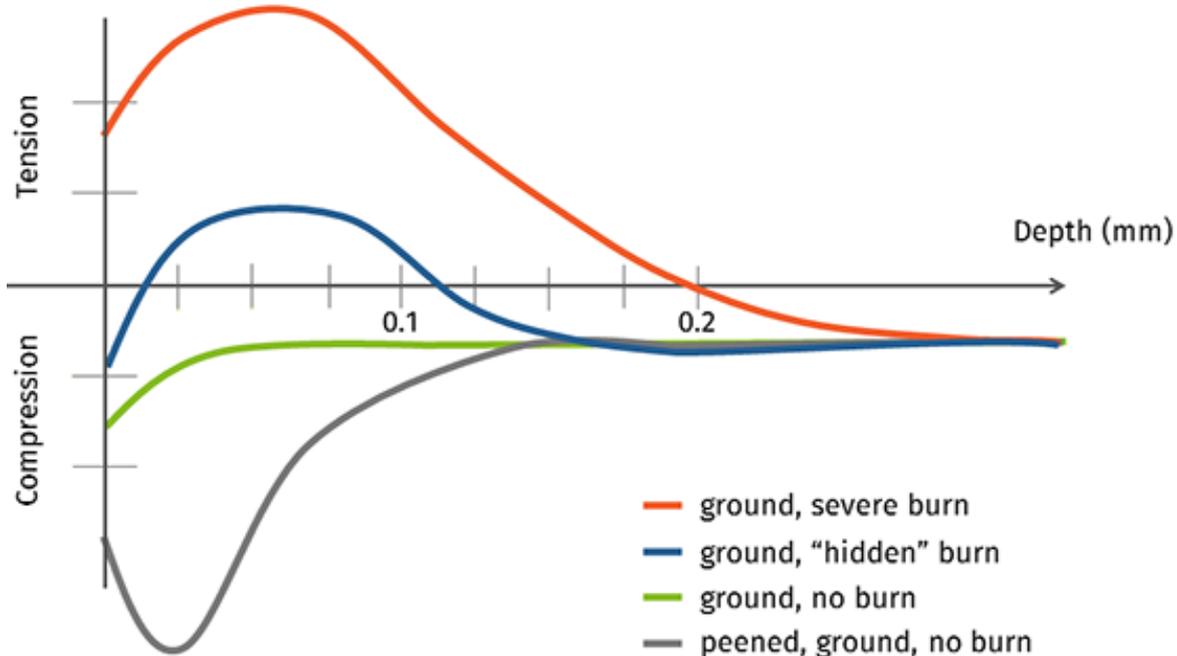
When we look at the residual stress changes during the grinding process, it is common that peak stress occurs between 10-50µm below the surface.

Barkhausen noise analysis meets the demand for detecting the damages in ground steels in a very reliable, standardized, cost effective and completely non-destructive manner. Combined with dimensional inspection, hardness tests and periodic metallographic analysis, the Barkhausen noise analysis method can help close the loop on insuring product quality.

Grinding Damages vs. Temperature

Temperature	Hardness	Stress	Nital Etching's Response
100°C - 150°C	Stable	Tension	Nothing
150°C - 350°C	Decreases	Tension	Grey
350°C - Austenization Temp.	Decreases	Tension	Dark
Above the Austenization Temp.	Increases	Compress	White

Grinding Damage – Typical Residual Stress Profiles



Case Study

Case hardened gears are finished by grinding process by an automotive gear manufacturer. To control the quality of the grinding operation, manufacturer was using the destructive nital etching method. Nital etching was causing substantial costs and scrap, besides subjective and operator dependent assessment, which motivated them to find an alternative method, preferably non-destructive.

The gear manufacturer wanted to make a correlation study, to verify sensitivity and capability of the destructive nital etching method and the non-destructive Barkhausen noise method.

They ground several teeth with varying feed rates and coolant flow, then tested these teeth with Barkhausen noise method and etched with nital-method. In addition

to these methods, they also used XRD to observe the residual stress profiles at locations where BN values were the highest.

The gear manufacturer found a strong correlation between residual stresses and Barkhausen noise values.

The conclusion was that they replaced the nital etching process by the completely non-destructive Barkhausen noise method

Barkhausen noise analysis can be a strong link in the chain that ultimately leads to a long and reliable product life.

Feel free to contact us for your grinding damage problems.

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