Evaluation of Case-depth Layer in Coated Cutting Tool by Using Barkhausen Noise and Electromagnetic Acoustic Emission Techniques

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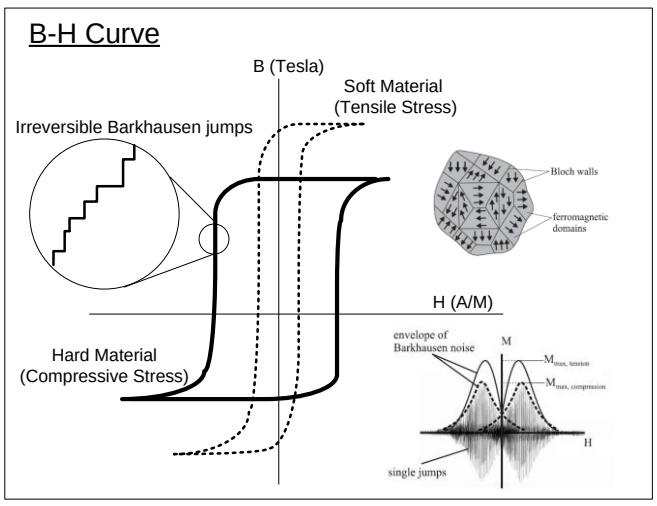
The hobbing process plays a key role in gear manufacturing. TiC and TiN coated high speed steels are generally used to produce the gear hob cutter and during machining operation the coated layer of its cutting edge slightly wears out until it breaks. Currently, traditional destructive methods such as micro-hardness profiling and metallography are used to evaluate the depth of coated layer; however, they are destructive, expensive, time consuming, and not suitable for real-time process control. Therefore, a non-destructive technique is required for cutting-tool monitoring.

The Barkhausen noise effect (BNE) can be found in ferromagnetic materials. When these materials are subjected to magnetic excitation, the magnetisation is not obtained continuously but in discrete jumps due to domain walls interacting and overcoming barriers in their path. Due to sudden changes in magnetisation; electromagnetic noise and acoustic signals can be detected by a pick-up coil or an acoustic transducer. Magnetic behaviour such as the shape of the hysteresis loop, coercive force, and permeability can be correlated to mechanical properties.

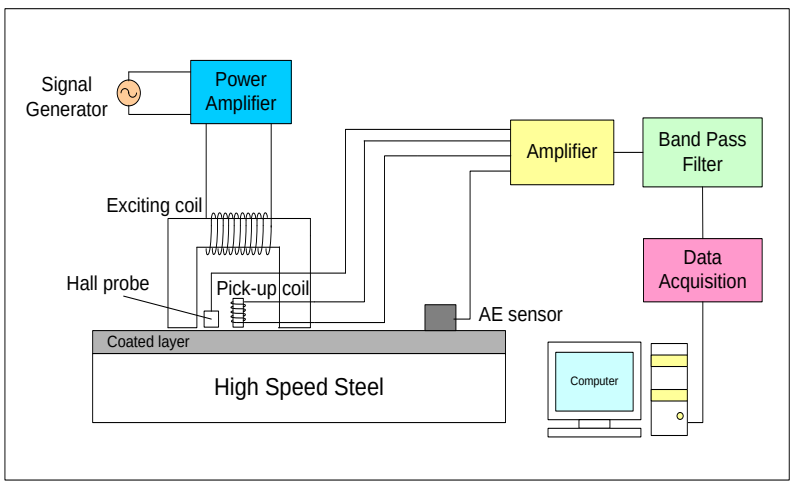


Acoustic emission (AE) is a non-destructive technique to monitor flaw formation and failures in structural materials used in service or laboratories. This method has been developed and applied in numerous structural components, such as steam pipes and pressure vessels, and in the research areas of rocks, composite materials and metals. AE can be generated by a variety of sources including crack nucleation and propagation, multiple dislocation slip, twinning, grain boundary sliding phase transformations and fracture of inclusion.

Project Aims:

- To evaluation case-hardened layer of coated cutting tool or other applications.
- To develop tool-wear monitoring of gear hob cutter in order to prevent production downtime.

Scope of Study:



This study focuses on measuring coated layer of high speed cutting tools by using BNE and AE techniques. Firstly, experiments focus on the characteristic of magnetisation behaviour of the coated tools in order to measure the harden layer of coated cutting tools. Secondly, AE is utilised as a novel method to evaluation coated depth. Both BHN and AE signals are processed and evaluated electronically. For case-depth evaluations, some useful signal parameters such as Root-Mean-Square, maximum peak amplitude, peak count, and cumulative values of these will be used. Thirdly, micro-hardness testing and metallography are necessary to validate the harden layer calculated from indirect measurement.

Materials and Equipment:

- TiC, TiN Coated High Speed Cutting Tool
- Data Acquisition Card
- Personal Computer
- Power Amplifier
- Exciting and Searching Coils
- Hall Probe
- Signal Conditioning Circuits
- Acoustic Emission sensor
- Micro-hardness testing machine

Methodology:

1. Micro-hardness testing in order to measure the case-depth of coated layer as reference values.
2. Design hardware interface between sensors and data acquisition unit.
3. Design algorithms to detect signals and signal processing using Labview software.
4. Experimental verification of the relationship between case-depth and several parameters by measuring coated specimens.
5. Comment on significance of results and propose optimum methodology to reliably detect the level of case hardening.

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