Quasar – The Revolution in NDT

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Abstract. In today’s automotive production world, parts are basically untested for performance. Independent studies prove, that the so called “conventional NDT” methods like X-Ray, Ultrasound, Eddy-Current or Liquid Penetrant Inspection do not correlate with the physical performance of a part. In a world where 0ppm is a serious goal, quality inspection has to be traceable, repeatable and without human error.

The Magnaflux Quasar Resonant Test is based on patented technology that has proven in a large number of applications to correlate with physical performance of the parts rather than with visual indications. Quasar is based on the basic principle that the internal stiffness of a part correlates to the part’s resonance characteristics. Changes in a part, for example defects like cracks, inclusions and so on, change it’s stiffness and therefore it’s resonance characteristics Quasar can measure the resonance characteristics and therefore identify good and bad production parts.

Quasar has developed a special method of exciting the part and can capture vibrations up to 1 MHz. The Quasar technology is not to be confused with Impulse Testing systems and operates completely different. The patented VIPR pattern recognition eliminates the natural differences that are caused by process variations and is able to discriminate real defects from good production parts. Since Quasar is based on the measurement of physical characteristics the results are quantitative, determinable and reproducible. Parts are rejected because of the structural characteristics.

Compared with other NDT methods, Magnaflux Quasar testing typically results in significant reduction of risk of delivering a bad part, and at the same time reduces testing costs per part.

Quasar Systems are targeted at companies in the areas of:

• Aluminum or Ferrous Casting
• Forging
• Powdered Metal
• Ceramic

The Quasar Test is fully automatic with no human interaction, and a typical automotive suspension part can be tested at a rate of 300-360 parts per hour.
Situation today

- Tighter requirements on products and processes
- 0ppm is a customer requirement
- Conventional NDT (e.g. XRAY, FPI, Eddy Current) does not correlate with physical performance measurements
- Parts are rejected because of visual indications
- “Invisible” defects are likely to be accepted
Sources of “Invisible” Defects

- In Castings...
  - Large oxide inclusions from accumulation in melt
  - Interrupted flow
  - Cool material or shot sleeve in squeeze casting
  - Die or mold release agent entrained in casting
  - High iron content or other alloy accidents
  - Broken or shifted cores

- In Forgings...
  - Inclusions, folds, cracks
  - Wrong material
  - Process Temperature
  - Heat Treatment issues

- …others apply for other production processes

Advantages of Functional NDT

- Reduce the possibility of a part failure in service
- Reduce scrap due to false rejects
- Process control feedback
- Lower testing cost per part
- Fully automated, no human error involved
- Modify future designs to reflect confidence in structural integrity of parts
Suggested Criteria for 100% Inspection System

- Measurements must relate to physical attributes
- Attributes must be related to known factors for part performance
  - Grain structure
  - Thermal history (e.g. forging temperature, spray quenching, annealing, induction heat treatment uniformity and symmetry)
- Severe geometry-dimension errors
- Cracks, laps, folds, significant inclusions
  - “Significant” refers to size of single inclusion or density of many small inclusions
- Steel alloys including carbon

“Defective Parts” = Defined by Laboratory and Destructive Tests

- “Matching Visual indications” not objective or useful
  - Surface indications can be cosmetic, superficial
  - Many serious structural shortcomings are invisible
- Classifying parts good or bad must be based on:
  - Destructive testing
    - metallographic, sectioning, hardness testing, fatigue, etc
  - Advanced methods as used in research
    - Micro-focus UT, X-ray micro-tomography
    - Mass spectrometry
    - Statistical estimation of inclusion severity
- “Process Capability” is one measure of control
Sources of failure

- Many factors contribute to part performance under load
- Unacceptable variation in many factors can cause premature failure
- Most of these variable factors are not detected by conventional NDT
  - Variation in Raw Material
  - Inclusions or other contaminants
  - Process Temperature issues
  - Heat Treatment issues

Goal: Improved Process Capability
Required: Objective Measurements

- A process capability index uses both the process variability and the process specifications to determine whether the process is "capable" of making the product as specified.
Required: Quantitative Measurements of Specified Physical & Structural Properties

• Resonant testing sensitive to elastic properties
  • Example: an increase of 1°C in steel reduces resonant frequencies about 0.015%. This is the practical limit of measurement by the Magnaflux Quasar resonant system.

• Elastic Properties relate to mechanical properties
  • With this sensitivity, many variables can be monitored
    • Grain structure and general and localized material properties
    • Thermal history (process temperature, spray quenching, annealing, heat treatment uniformity and symmetry)
    • Missed machining operations, severe geometry-dimension errors
    • Steel alloys including carbon
    • Cracks, laps, folds, significant inclusions
    • Residual stress, intended or unintended

USCAR Tests on 64 knuckles

So far the largest and most advanced industry consortium test based on Fatigue Testing of 64 Aluminum Knuckles, other studies exist.

Quasar had perfect correlation to fatigue testing
SUMMARY

- Magnaflux Quasar correlates to fatigue and not to visual indications
  - 100% inline testing of all Components in production
  - Objective, repeatable, no human judgment
  - Quantitative
    - Sensitivity to variations varies with physical differences
  - Structural
    - Sensitive to anomalies, local thermal history, geometry, etc.
  - 100% Correlation with performance
  - Built in process feedback

- NDT is not just crack detection
  - must test process capability

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