PART QUALITY INSPECTION APPLICATION:
RESONANT ACOUSTIC METHOD NDT

In the world of manufacturing today, the liability of shipping a defective part can be catastrophic for you, your customer, and the consumer. Non Destructive Testing via Resonant Acoustic Method (NDT-RAM) is designed to help you deliver fully inspected parts, economically and on time, giving you and your customers confidence in the quality of your parts.

The principle of Resonant Inspection is simple: every part has a unique resonant signature or pattern that reflects its structural integrity. A deviation from the expected signature or pattern can indicate the presence of a flaw. For example, a bell with a crack no longer has a clear ring or the ability to hold its tone.

The resonances of a structure are defined by its mass, stiffness and damping. These resonant frequencies can be measured in rigid materials including most metals, ceramics, and composites. NDT-RAM systems detect resonant frequency shifts which can be caused by imperfections such as cracks, porosity and voids, as well as variances in nodularity, dimension, geometry, weight, density and manufacturing processes.

Benefits

- 100% inspection - ensures that every part is objectively tested
- No part preparation required for inspection
- High throughput - approximately 3 seconds per part, typical*
- Simple to learn and use application software
- Reduces scrap costs associated with false rejects
- Greatly lowers operating expenses by eliminating consumables
- Industrial package - NEMA4 enclosure allows factory floor operation
- Versatility - same system can test many different parts
- Eliminates quality recall/containment costs
- Financially justified - ROI analysis available
- Durability - NDT-RAM systems have been running 24/7/365 in the plant environment for over 15 years

Typical Uses

- Production - In-Line Inspection
- Field Service - Troubleshooting
- Quality Control - Spot Checking
- Engineering - Development

Typical Applications

- Powdered Metal
- Castings
- Forgings
- Metal Stampings
- Bearings
- Ductile/Gray Iron
- Ceramics
- Composites
- Additive Manufacturing
- Braze/Weld Joints

CALL FOR FREE PARTS EVALUATION AND TEST REPORT
www.modalshop.com | info@modalshop.com | +1 513.351.9919

THE MODAL SHOP
MTS SYSTEMS CORPORATION
Who needs NDT Resonant Inspection?

- Have substantial inspection costs
- Require 100% parts inspection
- Desire to improve part quality
- Produce and/or use safety-critical parts
- Have customers demanding higher quality
- Have substantial scrap costs due to false rejects

What does NDT Resonant Inspection Detect?

- Cracks - Internal and External
- Porosity and voids
- Nodularity
- Residual stress
- Variations in hardness
- Bonding, welding, or brazing failures
- Machining or heat-treating processes
- Chips

NDT-RAM provides confidence and peace of mind.
It is simple, reliable, and affordable. Here’s how it works...

Every part has a unique resonant signature or pattern. Any deviation from the expected signature or pattern indicates the presence of a structural flaw or variation. A familiar example is a cracked bell that no longer has a clear ring and cannot hold its tone. NDT-RAM Systems objectively discern between small differences in complex parts that produce far more tones than a bell.

**IMPACT**

An industrial impactor triggers the test by tapping each part with a measured and repeatable force, producing sound.

**MEASURE**

A microphone is used to transform the sound generated (heard and unheard) into electrical signals for analysis.

**PROCESS**

The smart digital controller uses a Fast Fourier Transform (FFT) method to determine frequency characteristics.

**QUANTIFY**

NDT-RAM software compares the Frequency characteristics to criteria limits and accepts or rejects the part accordingly.

The resonances of a structure are defined by its mass, stiffness and damping. These resonant frequencies can be measured in most rigid materials including metals, ceramics and composites. NDT-RAM systems detect frequency shifts which are caused by imperfections such as cracks, porosity and voids as well as variances in nodularity, dimension, geometry, weight, density and manufacturing processes.

Changes in mass, stiffness, & damping due to certain defects can cause...

- Resonant peaks to shift in frequency.
- Peak shifts with more pronounced splits in resonant frequency.
- Resonant frequency peak energy to disappear completely.

www.modalshop.com
**NDT-RAM’s Graphical User Interface**

Graphic features provide easy visual and data evaluation.

Data shows color-coded spectra for good and bad parts against acceptable criteria ranges.

Clear indication of pass/fail by criteria range.

Investigate Mode supports up to 1500 part spectra, labeled good, bad, or unknown.

**NDT-RAM’s Report Generation**

Allows you to fine tune criteria by using standard spreadsheets to evaluate statistical data taken for each part tested. Data from NDT-RAM can be exported to Microsoft® Excel® for statistical analysis. Shown below is a typical scatter plot of resonant frequencies in a given criteria range for a lot of 5000 parts.

Structurally similar parts exhibit consistent resonant frequencies.

Statistical outliers indicate presence of a structural anomaly.
NDT-RAM SYSTEMS

- Ideal for in-line, automated, objective inspection
- 100% inspection of every part prior to shipment
- In-line monitoring to improve process
- Fast throughput - approximately 3 seconds per part, typical*
- Customizable conveyor configurations
- Adaptable to existing process automation

NDT-AUTO  Fully automated system for turnkey in-line 100% inspection

NDT-DF  Fully automated system for high volume sort of small parts

NDT-SEMI  Core NDT system components for implementation with existing automation

NDT-MAN  Manual system for laboratory or spot checking use

NDT-TS  Semi-automated test station for manual part placement with automated testing

**Defect Type**

<table>
<thead>
<tr>
<th>Defect Type</th>
<th>ET</th>
<th>MT/PT</th>
<th>UT</th>
<th>RT</th>
<th>RAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cracks/chips/porosity/voids</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Missed processes/operations</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Material property</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Structurally significant</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

**Defect Location**

<table>
<thead>
<tr>
<th>Defect Location</th>
<th>ET</th>
<th>MT/PT</th>
<th>UT</th>
<th>RT</th>
<th>RAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface (external)*</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Internal</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Brazing/bonding/welding</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

**Speed/Training/Cost**

<table>
<thead>
<tr>
<th>Speed/Training/Cost</th>
<th>ET</th>
<th>MT/PT</th>
<th>UT</th>
<th>RT</th>
<th>RAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part throughput</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Training requirements</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Overall inspection costs</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

**Automation Capacity**

<table>
<thead>
<tr>
<th>Automation Capacity</th>
<th>ET</th>
<th>MT/PT</th>
<th>UT</th>
<th>RT</th>
<th>RAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative results</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Automation requirements</td>
<td>*</td>
<td>N/A</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Automation cost</td>
<td>*</td>
<td>N/A</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

*NDT-RAM does not detect cosmetic flaws

**MAJOR COMPONENTS**

<table>
<thead>
<tr>
<th>Component</th>
<th>AUTO</th>
<th>DTF</th>
<th>SEMI</th>
<th>MAN</th>
<th>TS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LanSharK™ Smart Digital Controller</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>NDT-RAM Software</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Microphone</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Statistical Analysis Software</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Industrial Impactor</td>
<td>✓</td>
<td>✓</td>
<td>optional</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Impact Hammer</td>
<td></td>
<td></td>
<td>optimal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Force Transducer</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Industrial Computer</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Laptop Computer</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turnkey Conveyor System</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Part throughput rate dependent upon part size, belt size, data acquisition setup parameters, and other part handling requirements

**THE MODAL SHOP**

**3149 E Kemper Rd, Cincinnati, OH 45241 USA**

Phone: +1 513.351.9919 Email: info@modalshop.com

The Modal Shop, Inc. offers structural vibration and acoustic sensing systems and services for various applications in design and test laboratories as well as manufacturing plants. An extensive sound and vibration rental program, precision calibration systems, and both modal and vibration shakers are designed to simplify test phases. Non Destructive Testing Systems help manufacturers provide 100% quality inspection of metal components. The Modal Shop, Inc. is a subsidiary of PCB Piezotronics, Inc., and PCB® is a wholly owned subsidiary of MTS Systems Corporation. Visit The Modal Shop at www.modalshop.com. Additional information on MTS can be found at www.mts.com.