

# GrindoSonic

J.W. LEMMENS

## The Impulse Excitation Technique Non-destructive Materials Testing & Analysis

6.090 KHz

GrindoSonic  
THE IMPULSE EXCITATION TECHNIQUE

### Keywords

Impulse Excitation Technique; Analysis of Harmonic Vibrations; Non-destructive Materials Testing NDT, Young's Modulus; Poisson; Specific Damping Coefficient, Logarithmic Decrement, 100 % Quality Testing and Production Control

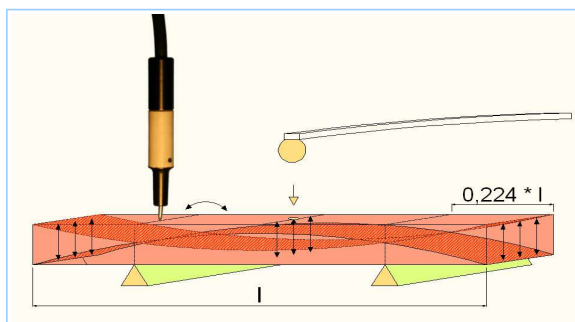
### Basics

The Impulse Excitation Technique and GrindoSonic constitute a fast and easily usable method to determine elastic materials properties.

The technology has been designed in the 1960s by J.W. Lemmens N.V. in Belgium in co-operation with the university of Leuven, Belgium and has continually been improved and enhanced. The idea behind the research work was to determine the hardness of grinding wheels. Universities and industry have since established that the hardness of ceramic compound material correlates directly with Young's modulus; the method has subsequently been described by various publications and standards world-wide. Today GrindoSonic covers an almost limitless range of materials and shapes which can be excited to vibrate in a defined and reproducible way. The natural frequency is being measured with an average reproducibility between 0.1 ... 0.01%. Materials which generally can be measured are metal, ceramics (technical ceramics, grinding and refractory materials), glass, building materials, concrete, stone, rock, carbon, wood, plastics and many more. Also composite materials can be measured easily; since the 1970s GrindoSonic has been a standard testing procedure for brake pads. A measurement requires merely 1-2 seconds, either manually or fully automated.

### Method and Technique

The sample (or production part which shall be quality-tested) is being excited by a single and elastic non-destructive tap. This can be accomplished by using a small tapping device or a simple hammer. In this way the test piece is being excited to vibrate in its natural frequency - amongst other frequencies. A probe (a piezo detector or a microphone) detects the vibration which then is being analysed by GrindoSonic. Various natural vibrations such as the flexural, longitudinal or torsional (and other) can be analysed in this way.



1: Piezo Detector / Flexural Excitation

This flexural natural frequency - the first harmonic - is determined by:

Young's Modulus  
Form factor S (Dimension), Density D

simplified:  $E = f^2 * S * D$   
(f = Natural frequency, S = material + Poisson specific)

The natural frequency is proportional to these factors. When entering the frequency, dimension and weight in to the GrindoSonic software Young's modulus and Poisson can be calculated.

## Industrial Quality Control

In industrial applications GrindoSonic supplies a powerful and non-destructive quality criterion. 100%-testing as well as production and process control are made fast and easy. Products are being classified according to their material characteristics, manually or fully automated. The Impulse Excitation Technique IET and GrindoSonic have been approved by many standards world-wide as a testing method with extremely fast and reliable results. Excellent correlations exist between destructive testing methods such as 3/4 point bending test and the non-destructive impulse excitation.

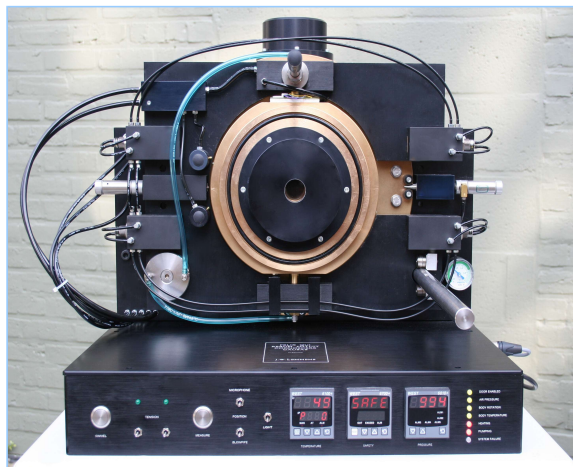
## Damping

Damping (the dissipation of energy) is one of three decisive criteria for material bodies - besides density and stiffness, which is being determined by GrindoSonic via the natural frequency. A vibration excited by an elastic impulse is called "free damped vibration". Inner and outer damping influences lead to a phase shift of the natural frequency. The industry has used this phenomenon with GrindoSonic for many years to indirectly detect cracks and inhomogeneities. However, GrindoSonic MK6 "Ultimate" offers the direct determination of the Specific Damping Coefficient or the Logarithmic Decrement of the natural frequency

## Research & Development

GrindoSonic supplies within a few seconds and with high precision materials characteristics such as

With the GrindoSonic high temperature measuring station ETMTS it is possible to determine material characteristics continually from room temperature up to 1200 deg C - with freely chosen ramp and measuring intervals. It is possible to analyse hysteresis behaviours, not only for drying cycles but also for heating and cooling cycles.



3: GrindoSonic – High Temperature Measuring ETMTS

## Summary

The Impulse Excitation Technique and GrindoSonic have been designed for 2 areas of interest: Research & Development and Industrial Quality Control. The testing method provides fast and easy results with extreme precision by analysing the natural frequency and the damping coefficients of a specimen. GrindoSonic testing generally applies to all geometries and sizes. It can easily be integrated in fully automated testing systems.

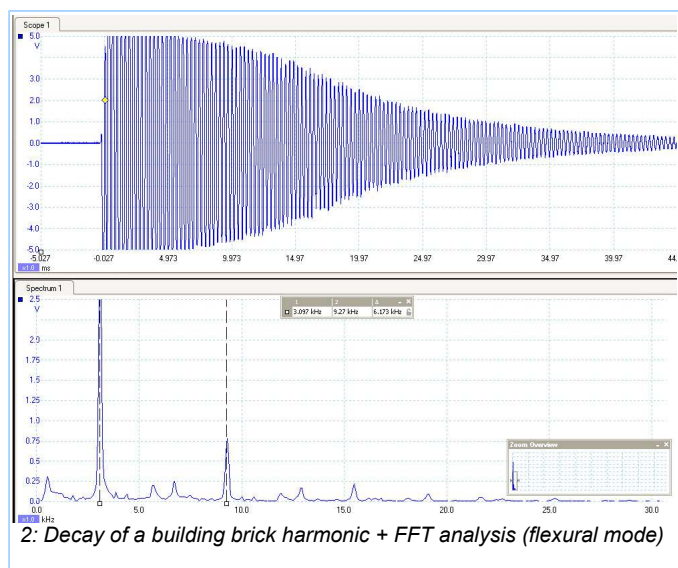
Many standards have implemented the Impulse Excitation Technique. Amongst others, EN 843-2 for technical ceramics concludes that the Impulse Excitation Technique provides the most reliable results and is least dependent on the test set-up.

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Young's modulus, G-modulus, Poisson and Damping constants.