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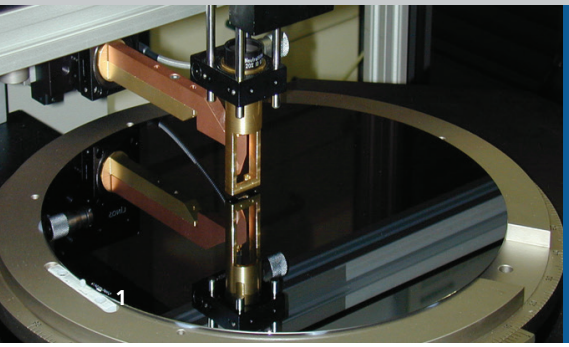
FRAUNHOFER USA CENTER FOR COATINGS AND DIAMOND TECHNOLOGIES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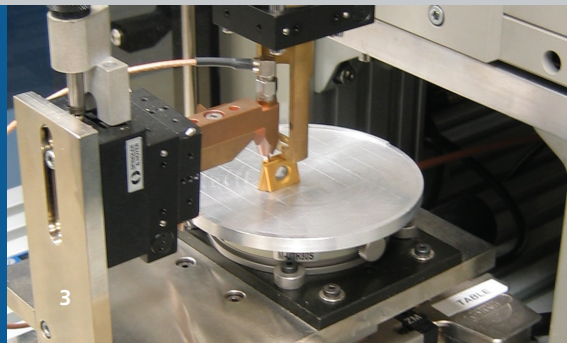
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1. **Wafer measured using LAwave®**
2. **LAwave® machine**
3. **Machine insert measured using LAwave®**

LAwave®

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IN COOPERATION WITH

MICHIGAN STATE UNIVERSITY

Non-Destructive Testing of Ultra Thin Films

LAwave® is a non-destructive measurment system that analyzes the material's stiffness and density with incredible accuracy even for ultra thin films. LAwave® is the only measuring device that is sensitive to films less than 5 nm.

It is a fast, non-destructive and highly accurate quality control tool.

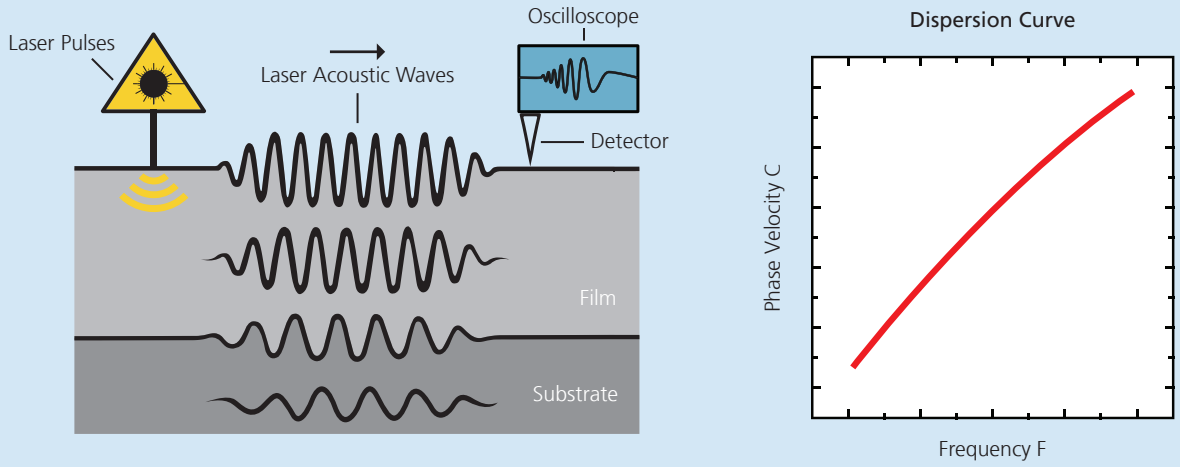
Background

Protective nanocoatings on applications such as hard disks, industrial tools, components and materials for semiconductor manufacturing must meet increasing requirements.

Mechanical testing of thin film coatings becomes exponentially more difficult with decreasing film thickness. When the thickness decreases below 200 nanometers conventional techniques such as mechanical indentation are unable to deliver precise results due to substrate effects. Fraunhofer developed the LAwave® to overcome these issues.

Features

- Non-destructive measurement
- Sensitive to films < 5 nm up to mm
- Multilayer analysis capability
- Fast measurement cycle (< 5 min)



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Overview

Performing the measurement is simple. The sample itself can be placed into the LAwave® machine. The substrate can be made of virtually any material as long as it allows propagation of a sound wave.

Applications

LAwave® can benefit a wide range of process development and quality control applications. Examples include:

- Measuring the Young's modulus of ultra-thin films < 5 nm
  Example: diamond-like carbon films on storage media
- Defect density analysis of highly polished surfaces
  Example: GaAs or Si wafers for semiconductor manufacturing
- Monitoring the quality of hard-metal surfaces and wear resistant coatings on machining tools
  Example: TiN coatings on WC tools
- Monitoring the quality of thin film coatings on components
  Example: engine components surface treated for sliding and rolling contact performance
- Analyzing the porosity of thermal spray coatings
- Quality control of heat treated surfaces
  Example: hardened steels

Film Materials

- Diamond-like carbon, diamond nitrides, carbides, oxides, ceramics
- Polymers
- Metals: steel, brass, Al, Ti, Mg GaAs, Si, other semiconductors

How it Works

The LAwave® tool introduces a sound wave to the sample surface and measures its propagation along the near surface region. The sound wave's phase velocity dispersion is analyzed, which depends on substrate and film materials. A mathematical algorithm determines the Young's modulus thickness or density of the film. The technique is sensitive to porosity, cracks and interfacial failures. A measurement can be taken within minutes and the samples remain intact.

Who Should Use LAwave®

For anyone requiring accurate and non-destructive analysis of ultra thin film properties, LAwave® is an invaluable measurement tool.

The benefits of using LAwave® were quickly recognized at IBM. Dr Ho-Cheol Kim at IBM Almaden Research Center has been using the LAwave® machine for over five years. Kim says: "We use LAwave® to measure the mechanical properties of our nanoporous ultra low dielectric constant materials. We find it provides us very reliable results."

How to Acquire LAwave®

To purchase a LAwave® system, simply contact Fraunhofer at 517-432-8709 to discuss your requirements.

LAwave® testing services are also available.

1. **Principle of LAwave® : A laser pulse initiates a laser acoustic wave, which propagates and is electromechanically detected.**