Fraunhofer IWS

LAwave

Fast and Non-destructive Mechanical Testing of Coatings and Surfaces

The LAwave laser acoustic method is used to determine the effective mechanical properties of coatings and surfaces. Its wide range of applications allows it to be used in research and quality control in an industrial environment.

The LAwave technology developed by Fraunhofer IWS is a fast and non-destructive method for the mechanical characterization of surfaces and coatings. It is based on laser-acoustic surface wave spectroscopy. By determining the effective modulus of elasticity of the coatings and the substrate, material-related and production-related characteristics in the material are precisely recorded. The method allows coatings in the range of a few nanometers to one millimeter as well as modifications to surfaces to be measured. For example, it recognizes the influence of pores, cracks, delamination, damage layers, textures and other process parameters on the coating integrity. Due to this high degree of flexibility, it can be used for surfaces and coating technologies such as CVD and PVD coatings, thermal spraying and laser cladding, surface layer treatments and many more. As a development partner, Fraunhofer IWS tests new applications, conducts system development, builds customer-specific measurement systems, creates quality assurance concepts and supports research projects for material and method development.

Method and Strengths

The method is based on broadband acoustic surface waves that are generated using a short, low-energetic laser pulse. Wave velocity is measured with frequency resolution using a piezoelectric sensor. Depending on the application, frequencies from 0.5 to 300 MHz are used. As the penetration depth of the surface waves is frequency-dependent, it is possible to draw conclusions about the depth-dependent properties from the different propagation speeds of the frequency components. The deformation of the material is purely elastic. The Young's Modulus, the layer thickness, the density and small defects such as cracks or pores influence the wave propagation so that the effective properties are measured. The

Main Features

- Determines mechanical properties of coatings and surfaces
- Non-destructive
- Measurement in seconds
- Flexible coating thickness range from a few nanometers to approximately 1000 µm
- In-situ measurement from room temperature up to 600 °C

More Information

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Application examples of the LAwave technology.

large measurement area of about 5 x 10 mm² provides integral information. With its high precision, the method is an important alternative to nanoindentation, demonstrating its strengths in areas such as quality assurance of high piece counts and the examination of extremely thin layers in the nanometer range.

For thick coatings, which up to now have only been examined destructively in cross-section or inaccurately by means of indentation techniques due to the influence of pores and cracks, it often represents a non-destructive examination option for evaluating the actual mechanical coating behavior or the coating thickness.

System

The strength of the LAwave technology is based on extensive and long-standing expertise in measurement physics, system and software development and materials science. It allows to adapt modular measuring systems to customer-specific requirements in terms of geometry and measuring task. The integrated control and evaluation software makes it possible to intuitively evaluate and compare the data using a material model, even without in-depth expertise. A recipe function allows reproducible and traceable measurements to be taken with minimal user interaction. Alternatively, full control of the measurement and evaluation parameters is also possible.

Applications

The high flexibility of the measuring system allows it to be used for numerous surfaces and coating technologies:

- Thin films from PVD, CVD or ALD processes
- Thermal spraying and laser cladding, e. g. isolation coatings or brake disk coatings
- Generated volume materials
- Hardened and nitrided surfaces
- Shot peening, preparation damage, sawing damage, e. g. of semiconductor materials

Development

The development of new applications is ensured by continous advancement of measurement technology and software. This includes the development of high-temperature resistant sensors and the automation of the measurement and evaluation process. On-site applications and measurements on very large components will be made accessible in future with a mobile measuring head.

LAwave measuring system for fast and non-destructive characterization of small and medium-sized components.

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