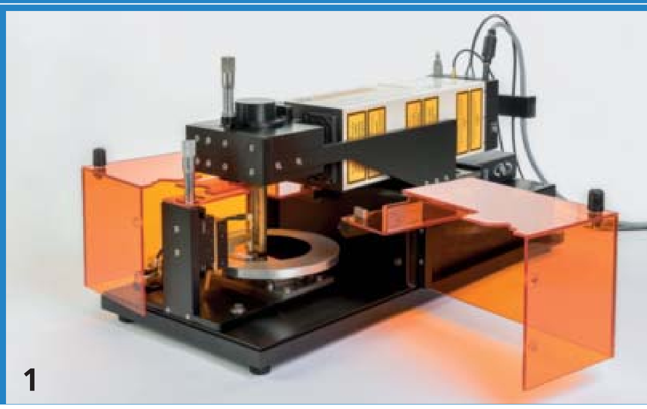
LAwave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LAWAVE 2G – A NEW DEVICE FOR TESTING OF SURFACES AND COATINGS

THE TASK

Laser acoustic testing has occupied a prominent position among coating and surface characterization methods for some time. During that time, LAwave devices have successfully come into use worldwide, such as in Japan, China, the USA, Russia and Great Britain (UK). The measuring technique performed using surface waves is non-destructive, works quickly and is extremely sensitive to minor alterations in the surface properties; it is used, for instance, to analyze the Young's modulus, density or layer thickness (Fig. 2). The wide range of application ranges from nanometer thick functional coatings, to thermal spray deposition of coating several hundred micrometers thick, and damage layers caused by wafer processing to hardened steel surfaces.

Greater demands for performance, convenient handling and an option for a flexible integration of the solution into process inspection, as well opening up new fields of applications, motivated the Fraunhofer IWS Dresden to consistently refine the proven measuring technique.

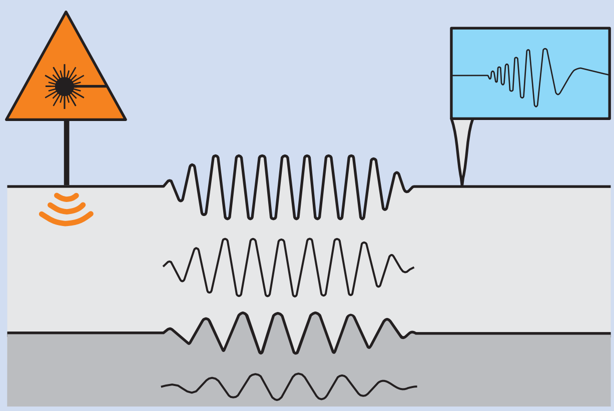
OUR SOLUTION

The new generation of equipment, LAwave 2G, is characterized by improvements in terms of handling, size, technical capability and expanded analysis options. A new equipment configuration with a stationary table for the specimens and a laser that can be positioned minimizes the influence of multiple test specimen weights. Thus, it is possible to flexibly accommodate test specimens and components of any size, which is, in turn, a precondition to integrate the equipment into automated processes (Fig. 1).

New space-saving components permit compact installation with enhanced technical capability. The mass of the new LAwave 2G system is 40 kg in contrast to the 160 kg of the original system. Only one third of the space of the original version is needed, so there is enough space on any table (Fig. 3). For these reasons, transport and installation are much easier.

To cover various ranges of application, measuring heads with a modular design allow for an adjustment to different frequency ranges on demand. The foundation for the analysis of multilayer systems lies in the integration of a new analysis model into the software.

LAwave measuring principle: A laser generates acoustic surface waves (left) that are recorded by a sensor (right). The wave packet includes depth-dependent information allowing for conclusions on the material parameters of both the bulk material and the surface.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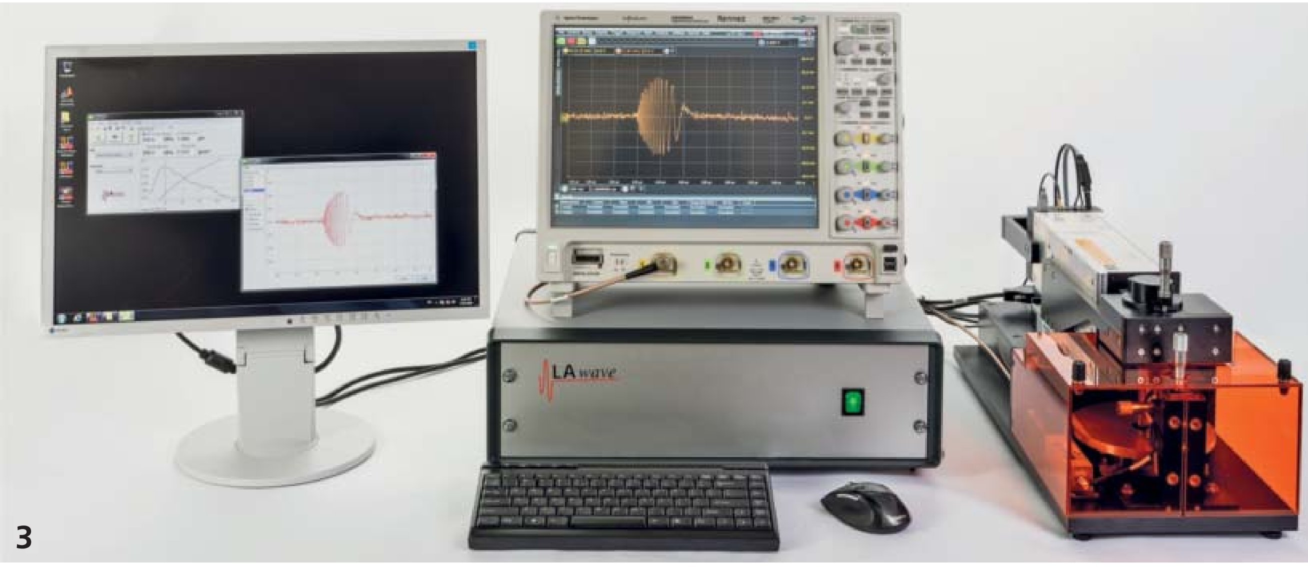

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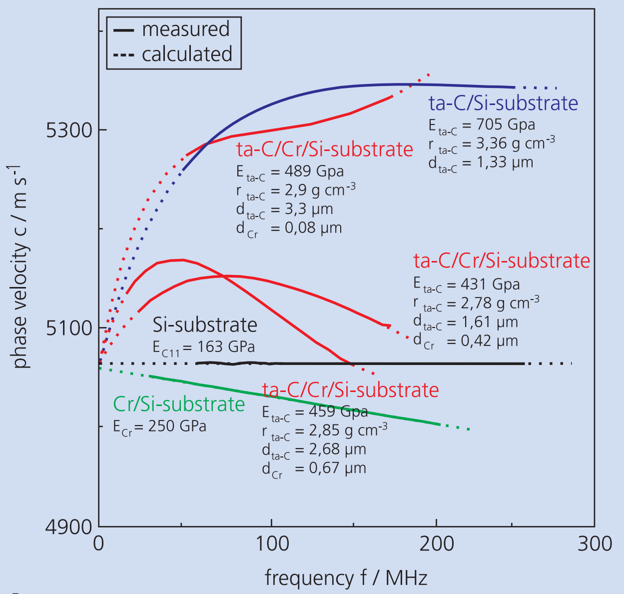
RESULTS

A layer system with a tetrahedral amorphous carbon coating (ta-C) and a chromium interface layer on a silicon wafer was measured in several variants by means of the LAwave method. The curves of the frequency-dependent phase velocities are distinct even with minimal differences in the layer system structure (Fig. 4). The material parameters – Young's modulus E, density r and layer thickness d – determined from the so-called dispersion curves by means of the analysis software are listed next to the curves.

The phase velocity of the uncoated silicon is constant and thus independent of the frequency. If a chromium coating is deposited onto the silicon (Cr/Si), the curve decreases in comparison with the substrate due to the difference in density between chromium and silicon, from which Young's modulus can be calculated.

Measured and calculated dispersion curves for the material systems Si (black), Cr/Si (green), ta-C/Si (blue) and several variants for ta-C/Cr/Si (red), as well as the material parameters determined from them.



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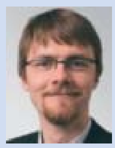
If, instead of chromium, a hard ta-C coating is deposited onto silicon (ta-C/Si), the curve clearly rises as a result of the difference in Young's moduli. Young's modulus, coating thickness and the density of the ta-C coating can be determined simultaneously from the multi-curved curve. When combining a ta-C coating with a chromium interface layer (ta-C/Cr/Si), the influences of both layers lead to a strong, partially multi-curved curve. Four material parameters can be calculated from the curve; in this example, it is also possible to compute the thickness of the different well-defined chromium interface layers.

Many innovations, such as changes in design, adequate component choice and analysis software, make the LAwave method a technique that may be often and flexibly employed for new applications in research, development and production inspection.

1, 3 LAwave 2G, designed as a compact tabletop device for R&D. The setup of the stationary table to hold the specimen also makes it possible to adapt the system for large components and test specimens.

CONTACT



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