Separating the Wheat from the Chaff

Vibrometers spell success for quality assurance

It's not so advisable these days to leave the good/bad decision to the wind, not just because it blows so rarely in factories and laboratories. It has become more important than ever to quickly and reliably differentiate the good from the bad.

The economic success of a product, in both the consumer and capital goods industries, is determined to a large extent by how well quality, production processes and costs are optimized. Quality assurance in manufacturing relies on fast, automated and robust test methods. Structural defects can be revealed by analyzing the dynamic properties of components, assemblies or the final product. Features such as changes in natural frequencies, amplitudes and mode shapes are characteristic quality markers. Therefore, with a suitable measurement, evaluation and classification of these parameters a fast and automatic good/bad selection is possible on the product or component level. For many such applications in the final inspection of production, laser vibrometers are particularly suitable because they offer considerable advantages compared with conventional sensors such as accelerometers or microphones. In addition to the wide dynamic range and the large bandwidth of vibrometers, their non-contact measurement principle and ability to target with pinpoint precision are crucial. ►

Non-contact means that the measurement method doesn't influence the data being acquired. Integration becomes easier because there is no physical contact with the samples. The method is not susceptible to ambient noise etc. because the vibrometer captures the vibrations directly on the sample surface. Operational costs are further reduced by fast change-over, easy calibration and lower repair expenses.

HOUSEHOLD APPLIANCES AND MEDICAL TECHNOLOGY

Electrically driven household appliances, medical devices or their components which generate unwanted vibrations and noise, can be identified in production with laser vibrometers for removal from the line. Examples are washing machines, vacuum cleaners, electric toothbrushes, dental instruments or motors for medical devices. Vibrometers confirm the proper function of hi-tech medical products such as membrane inhalation systems with 100% testing.

Thanks to 40 years of close cooperation with the world's largest washing machine manufacturers, the Loccioni Group is a leader in the development of automatic quality control systems for laboratory and in-process applications. Their MUSA test station (Measurement Unit in Sound-proof Area) is a fully automated turnkey installation for vibration and noise testing on washing machines, which traditionally is carried out in the laboratory.

Figure 1: Testing of washing machines (Loccioni)

Experience has shown that spot checks on systems selected at random do not result in a reliable outcome. Only 100% testing on the finished products guarantees a high quality standard. Vibration tests are a good method for distinguishing good from faulty products. Therefore, the use of vibration analysis for quality control of household appliances is highly recommended. Laser vibrometry has firmly established itself as the non-contact method of choice for in-line testing. With the help of the laser vibrometer, the system reliably detects possible defects such as faulty or loose components or machine tub unbalance.

AUTOMOBILE INDUSTRY AND MECHANICAL ENGINEERING

Laser vibrometers are already widely used for manufacturing inspection in these fields. They perform noise and failure analyses on components with moving parts such as combustion engines, gear drives, A/C systems, injection valves, steering systems, adjusters and miniature drives, as well as for material testing, e.g. on camshafts or light bulbs.

Roller bearings are high-precision components manufactured in large numbers. SKF is the world market leader, continuously expanding its lead in manufacturing and quality technology. SKF noise inspects 100% of manufactured roller bearings. Highly efficient test systems are required to achieve goal cycle times of a few seconds. Therefore, the measurement technology center of the SKF Group (QTC – Quality Technology Center) decided in 2010 to rely on optical measurement technology employing IVS sensors from Polytec. Advantages for SKF are the non-contact principle, signal quality, as well as lower operational costs from the quick sample changeover, simple calibration and lower repair expenses.

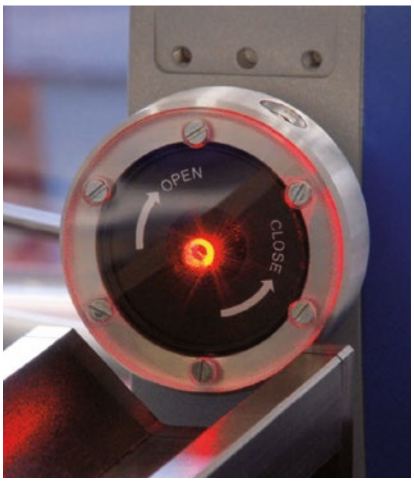

Figure 2: Testing of roller bearings (SKF)

INFORMATION AND MICROSYSTEMS TECHNOLOGY

Vibrometers are used in the manufacture of hard drives as highly sensitive detectors of unwanted deviations in the dynamic behavior of read-write heads and other fine structures. Another related application is the component testing of DVD players or bubble-jet printers.

The static and dynamic properties of microsensors, microactuators and other MEMS components can be tested during manufacture on the wafer level with the MSA Micro System Analyzer or other microscope-based vibrometers.

In many MEMS, critical geometric and material parameters, which can't be measured directly with other non-destructive methods, can be deduced from the results of a vibration measurement. Examples are the determination of membrane thickness of MEMS pressure sensors or the spring thickness of MEMS Fabry-Perot interferometers which are used as tunable IR filters. The procedure can be completely automated: The structure to be examined is excited in broadband mode on an automatic probe station by a special probe card with a transparent electrode made of indium tin oxide (ITO) and an electrostatic stray field on the wafer. The mechanic vibrations stimulated in this way are measured by means of a laser vibrometer. The frequency response function and selected resonance frequencies are determined very precisely from the measured data and known excitation signal.

A MEMS model, comprising polynomials, is adapted to the resonance frequencies by parameter adaptation. Thereby, the required geometry and material parameters are calculated very precisely. The polynomials can be extracted from the parametric FE simulations before starting the measurements. The calculations which are necessary during the series tests for parameter adjustment can be carried out very efficiently. The measurement is fully automated for all devices on the wafer. The procedure is therefore well suited for 100% inspection during MEMS fabrication. ■

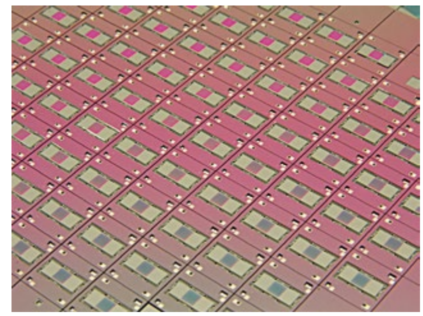

Figure 3: Automated testing of Fabry-Perot MEMS sensors (FHG ENAS)