Paint Inspection in Aerospace

A Perfect Finish – When Sensors Measure Ultrathin Paint Films

Measurement of paint and coating thicknesses is performed both in the high-accuracy range in aerospace as well as in industry. Among other techniques, the microwave-based FSC and ISC coating thickness gauges from Micro-Epsilon are used to analyze very thin coatings on CFRP and metals. The hand-held devices permit non-destructive, precise measurements.

Coating-thickness measurements are needed in many industrial sectors. They are used in running production processes, quality testing, process monitoring and optimization, as well as predictive maintenance. The best known methods for measuring the coating thickness on CFRP or CFRP with lightning protection mesh are polished micro-sections and wedge-cut methods. These methods destroy or damage the object being measured. Laborious finishing of the measurement site is necessary. Modern layer thickness measurements no longer destroy the materials. Measurement devices from Micro-Epsilon permit non-destructive measuring with micrometer accuracy. Now, not only can samples be assessed, but large-area checks can be performed in an extremely short time. Cars, ships, aircraft and sheet metal are only a few examples in which materials are coated. These coatings are necessary for various reasons, such as corrosion protection, for optical reasons, saving materials and resources or to increase the lifetime. The correct coating thickness is a key factor here.

Precise Measurements with Microwave Technology

To measure total coating thicknesses of insulating materials on CFRP and metal substrates, non-destructively and without a coupling medium, Micro-Epsilon has made coating thickness measurement by microwave into a mature series process. It involves making precise, non-destructive measurements of the total coating thickness of insulating coatings on conductive and weakly conductive substrates. This is possible with microwave technology (24 GHz/HF), which is integrated into the hand-held units.

According to Micro-Epsilon, the hand-held units are sensors for measuring the thickness of paint on CFRP composites, any metals as well as thin films from 1 µm thickness and with 1 µm resolution. Measurement is non-destructive and residue-free.

The Micro-Epsilon gauges are qualified as thickness measurement devices for the aerospace industry and are used by well-known aircraft manufacturers, airlines and paint shops for micrometer-accurate measurement. In industrial applications they are used for sample and quality testing, as well as for process control on CFRP substrates and any metals and thin metal foils. The measurement result can be read directly on the display as an individual value – already an average of several individual measurements. It is also possible to record a series of measure-

The ISC1000 uses microwave technology to measure the total layer thickness of insulating materials on CFRP and metal substrates in a non-destructive way without a coupling medium. © Micro-Epsilon

ments: in this case, the mean value, standard deviation and the max./min. values are automatically determined and displayed directly as statistics. The measurement data are stored in the controller and can be easily exported via USB and further processed in a spreadsheet.

Difference from Other Measurement Methods

Compared to conventional processes, the advantages of Micro-Epsilon technology are to be found in the simple, rapid and precise measurement. In addition, measurement is accurate to the micrometer without influencing the measurement object. In contrast to magnetic methods using the eddy current principle, the microwave sensors are metal-independent and can measure even very thin coatings on very thin objects: independently of the electrical and magnetic properties of the metal substrate. While, for optical sensors, the coatings must be transparent and the refractive index must be known, this is not necessary for microwaves. A minimum coating thickness and a coupling medium are also not necessary.

Thermographic determination of the paint thickness would also be conceivable, however this is often only possible via comparative measurements. Influences due to the fluctuating temperatures of the measured object and inhomogeneous temperature distribution on the surface are neutral for the microwave sensors. With the sensors from Micro-Epsilon, it is also not absolutely necessary to adjust to the particular material, depending on the substrate material and application. Measurements can also be performed on unknown substrates. For measurement, the non-aggressive plastic face surface of the sensor is placed by hand on the area to be measured. The result of the measurement is available in less than one second. The configurable dynamic tilt prevention always ensures stable and accurate results. The measurement data are stored after evaluation. The measurement ranges are between 0 and 1000 µm.

Measurement of Aircraft Paints

Particularly in the aircraft industry, determination of the exact paint thickness is a significant factor. Why does it have to be measured? If the paint is too thick, it adds extra weight. The paint can also become brittle or chip off due to mechanical stress and poor elasticity. Another aspect is safety: paint that is too thick affects the lightning protection. If it is too thin, it has an effect on the UV resistance, corrosion protection and abrasion resistance, among other things. To ensure quality, costs, safety and durability, it is important to have a correct knowledge of the paint thickness.

When aircraft are newly painted, balancing may be necessary, depending on the type. For this application, too, non-destructive measurement offers significant advantages. Instead demounting the elevator, rudder and aileron for static balancing, a balancing can be computed. In this case, measurements are made at fixed points before and after painting and a difference determined. This allows conclusions to be drawn about the counterbalancing weights relatively easily.

The use of the coating-thickness gauge offers a quick, efficient and cost-saving solution in many applications. At the same time, hand-held mobile devices can be easily used at the touch of a button. For increased accuracy, they are adjusted to the particular material, but measurements on various and ultrathin materials, without a minimum coating thickness, are also possible without adjustment. The adjustments can be saved and repeatedly retrieved again. The devices are used, for example with transformer plates and coils, in the automotive and aircraft industry. ■

Typical structure of an aircraft paint coat. The coating thickness has an influence on weight, lightning protection, UV resistance and corrosion protection. © Micro-Epsilon

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