White Paper

The coating of household appliances requires innovative solutions for coating thickness measurement

The interior coating of a baking oven must be scratch-resistant as well as easy to clean and withstand temperatures up to 500°C. Today, a glass-ceramic powder material is used for this purpose, which poses particular challenges for quality control in terms of coating thickness measurement.

The market for household appliances as an unrecognized giant

In the shadow of the glittering world of consumer electronics, the household appliance market appears rather inconspicuous – quite wrongly. Sales of so-called white goods amount to around 110 billion euros worldwide and have been growing steadily by around 5 percent for years. The industry is also highly innovative. The smart home megatrend is setting a completely new course. Rising energy prices and growing environmental awareness are shaping consumer behavior and driving developments.

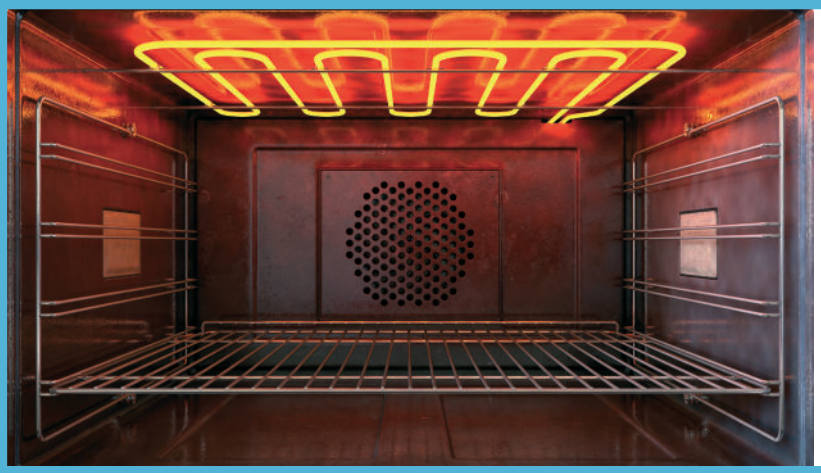
Today, a glass-ceramic powder material is used as a coating for the cooking chamber of an oven, which poses particular challenges for quality control in terms of coating thickness measurement.

The mega trend is called Smart Kitchen

Smart Kitchen is the epitome of intelligent kitchen appliances that optimally combine innovative functions and sophisticated design. Flexible, efficient, energy- and resource-saving: these are the requirements not only for the products, but also for their production. Large parts of household appliance production have long been fully automated, with maximum precision and speed. This increases quality and reduces costs – provided that quality control is equally optimal.

Tomorrow's ovens as multi-talents

For years, household appliance manufacturers have been putting a lot of energy into further developing their products so that tomorrow's kitchen will be even smarter, more efficient and easier to use: transparent refrigerators, cooktops with integrated extractor fans and dishwashers that clean with an entire wall of water are among the industry's showcase innovations. And there are surprises in store for ovens, too.



The PaintChecker industrial from OptiSense heats up thick, glass-ceramic powder coatings sufficiently fast for coating thickness testing and does not require any complex precision positioning.

Ovens have long been true multifunctional devices that can do much more than bake, cook and roast. In addition to classic convection, bottom heat and top heat, current models have numerous additional functions. Microwave, pizza level and also the particularly gentle sous vide and steam cooking are already integrated. In ovens with a divisible cooking chamber, different dishes can be prepared at the same time, even with different temperatures and cooking times.

Requirements for the coating of the cooking chamber

The cooking chamber is the most heavily stressed part of an oven. Even in normal operation, heat levels of up to 300°C prevail here. In addition, there are temperature shocks when the raw goods are placed in the oven. Steam vapors or acidic foods attack the surface and fat splashes burn into it.

The self-cleaning process places an even greater strain on the coating. Catalytic oxidation requires a very smooth but highly porous surface. Splashes and fatty vapors spread as a thin film in these pores during baking and are burned there. If something has nevertheless stuck, steam cleaning kicks in after baking. This generates superheated steam that condenses on the coating of the cooking chamber and thus dissolves the impurities. If anything remains, pyrolysis removes the rest. This heats the oven interior to 500 °C and even stubborn dirt decomposes into an ash residue that can be easily removed.

Added to this is wear and tear in daily use. The coating must be easy to care for, scratches and knocks should have no consequences, and somewhat rough cleaning methods must not cause any damage.

The cooking chambers are coated fully automatically with glass ceramic powder by a painting robot and then cured in an oven at temperatures of 850°.

The ultra-thick high-tech ceramic coating

Coatings that can permanently withstand such stresses can only be produced in series using special, highly developed materials, fully automated production processes and careful quality monitoring. Instead of the liquid enamel dispersion used in the past, a glass-ceramic powder material is now used, which allows a much more uniform coating thickness to be achieved. The powder is applied fully automatically by a painting robot and then cured in an oven at temperatures of 850°. At 800 µm, the ceramic coating is significantly thicker than conventional powder coatings to meet the tough demands of everyday kitchen use.

Quality inspection sought before baking

If it turns out after baking that the coating thickness is outside the tolerance, the component can only be rejected as scrap. To optimize quality, it would therefore be ideal to check the powder layer thickness before curing and, if necessary, to recoat.

Easier said than done, because the measurement must be made on the very sensitive, uncured powder layer without damaging it. Also, measurements should be taken at several different positions to assess the overall quality of the coating. And all this inside the cooking chamber, where space for measurements is extremely limited.

The solution: coating thickness testing via photothermics

A suitable measurement principle is found in the photothermal process, which can measure the thickness of coatings in a non-contact and non-destructive manner.

The different thermal properties of the coating and substrate are used to determine the absolute coating thickness.

The surface of the coating is heated by a few degrees with a short, intense light pulse and then cools down again by dissipating the heat in deeper areas. The thinner the coating, the faster the temperature drops. The temperature profile over time is recorded from a distance by a fast, highly sensitive infrared sensor and converted into a corresponding coating thickness. The point-shaped measuring spot means that corners and edges of the cooking chambers can also be measured precisely.

High-power measuring system with multiple sensors for reproducible results

The photothermal measurement process thus provides a fast and efficient method for quantitative coating thickness determination that delivers accurate, reproducible results and is ideally suited for use in highly automated production lines. However, many conventional photothermal measuring systems weigh more than 15 kg, at the corresponding size and can only measure at one point.

The PaintChecker industrial n-gauge from OptiSense, with its eight sensor heads measuring just 10 cm in length, is tailor-made for the task. In order to heat the thick, glass-ceramic powder layer sufficiently fast, the high-performance high-power variant is suitable as the sensor type. This also allows a much greater tolerance of the measuring distance. Once the coated cooking chamber has been moved into the measuring station, the measurement can be started directly without having to position the test specimen precisely first. The sensors maintain a sufficiently large distance from the cooking chamber walls to reliably prevent damage to the sensitive powder coating.

Conclusion

Even thick ceramic powder coatings can be measured photothermally and even multi-point measurements can be realized with the PaintChecker industrial n-gauge in a very small space. Rejects can thus be reliably avoided and productivity significantly increased.

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