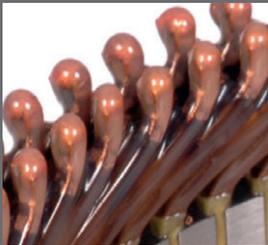




CASE STUDY RELIABILITY OF HAIRPINS IN ELECTRIC MOTORS

VOID ANALYSIS BY X-RAY
COMPUTED TOMOGRAPHY



Welded hairpins

With the electrification of the automobile, the technology of the electric motor is experiencing a renaissance.

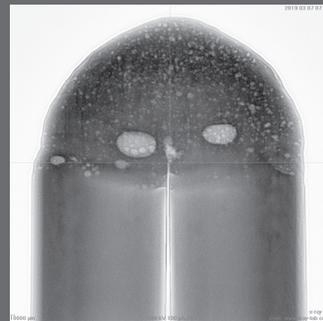
In order to increase the performance with reduced component size and reduced weight, more and more manufacturers rely on a laser welding of the copper-hairpin.

More than 200 hairpins are attached to the ends of the windings on the stator and welded using a laser beam.

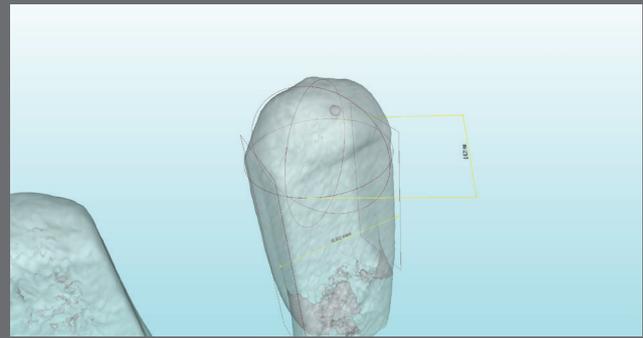
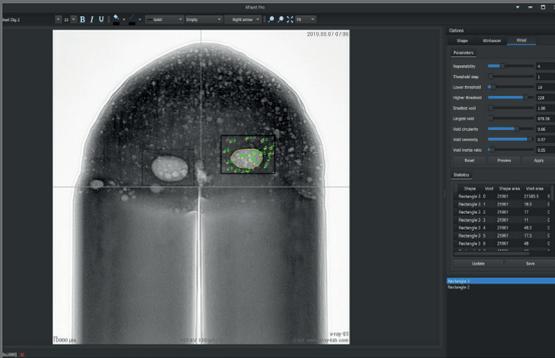
The welding process takes about 90 seconds to connect all hairpins. In the process, air pockets or incorrect connections can occur during welding.

These hairpins can be measured by X-ray 2D or 3D to be sure that there is a void-free connection and that the optimal geometry has been maintained.

Voids (air bubbles, voids) act like an insulator. The electrical resistance is increased and it loses power and range.



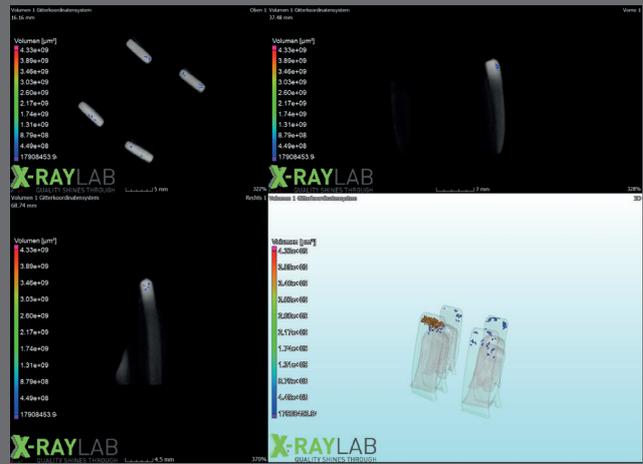
The white dots are the air pockets (voids) in the laser welding



Measuring the geometry

With the XPaintPro Software, these air pockets (voids) can be partially or fully automatically evaluated in 2D. The air percentage of the individual pores is calculated as a percentage of the welding area and a protocol per hairpin is created.

Evaluation by using Computed Tomography



3D examination (CT) with voids analysis. It is possible to determine the defect volume as well as the volume of the object. Each individual inclusion can be evaluated separately in volume, diameter and geometry.

On the basis of the coloration and the color scale, the volume of the air bubbles (voids) can be visualized. Based on these evaluations, the welding process can be optimized.

All evaluations can be carried out manually under laboratory conditions or integrated fully automatically into the production process.