

A Novel Holographic Method to Measure Residual Stress on Coated Surfaces

This new digital holographic method enables a temporal, spatial and precise measurement of residual stresses in coated surfaces via an optical and contactless approach.

- Measuring residual stresses on coated surfaces regardless of their geometry.
- Real-time measurement without interrupting the manufacturing process.
- A potential substitute for hole drilling or X-ray method.



Fields of application

Advanced manufacturing, additive manufacturing, sophisticated coated surfaces (e.g. aerospace structures or oil and gas industries),

Background

Industrial surface properties are often coated to be protected against corrosion, wear or for other purposes, so their thermophysical and electrophysical properties will be improved. High-energy coating processes often leave significant residual stresses, which can affect the coating behaviour and reduce the lifetime of the coating and, consequently, the surface. The residual stresses may cause the surface to crack or flake and, hence, shall be measured and managed before the structure is operated.

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Development Status

TRL 4 – Technology validated in lab.

Patent Situation

US 10,481,020 B2 granted
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Reference ID

15/015TLB

Service

Technologie-Lizenz-Büro GmbH has been entrusted with exploiting this technology and assisting companies in obtaining licenses.

Problem

Different coatings are commonly used to improve the wear or heat resistance of many technical components or provide electrically non-conductive surfaces. However, due to their application process, e.g., plasma or high-velocity oxy-fuel spraying, rather high residual stresses can be generated within the coating and underneath. A variety of techniques can be used to analyse residual stresses in coatings, such as X-ray, synchrotron or neutron radiation, or hole drilling. These methods are either time-consuming, stop the process or need to be more accurate for this purpose and thus unsuitable to be used in real-time during the coating process.

Solution

Researchers at the University of Stuttgart have developed a novel digital optical, holographic contactless method to measure residual stresses in coated surfaces precisely and in real time.

A pulse laser is applied on the coated surface, which locally removes or heats and deforms a small part of the coating layer. Using a beam-shaping device such as a Spatial Light Modulator (SLM), one can adapt the projected pattern to the topology of the surface. A little scratch on the surface releases the residual stresses. Then, the deformed shape of the surface is measured using digital holography. The residual stresses in the layer can be determined and measured numerically via continuum mechanics calculations and finite element methods to accurately define the residual stress states. This advanced optical method can be used on curved surfaces as well. This process can be made very fast to run during the coating process and to control the coating with respect to a minimum of residual stresses.

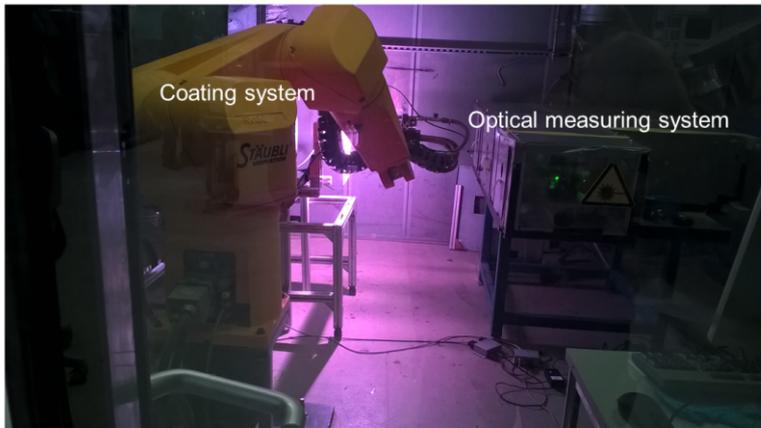


Figure: Coating system and optical measuring system [Fig: ITO, University of Stuttgart].