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WASHER SENSOR SYSTEMS – UNIVERSAL AND INDIVIDUAL

Thin film-based sensor systems offer the ideal conditions for application-oriented solutions and innovations in industrial production processes. For many years now the Fraunhofer IST has been a leader in the field of thin film sensor systems and has a broad cross-industry expertise in sensor technology, coating development and micro structuring. Lately a new kind of washer sensor based on the piezoresistive thin film DiaForce® has been developed.

Structure of the thin-film sensor system

The requirements made of this innovative washer sensor differ from customer to customer. The system, which was developed at the Fraunhofer IST, can be customized to individual needs. Here, customer-specific measurement points are deposited from a layer of chromium 200 nm thick onto the base layer of DiaForce® (d=6 µm). The measuring system is completed by the following layers:

- | an electrically isolating intermediate layer of SICON®; d=1 µm,
- | conductors and temperature sensor made of a chromium layer 200 nm thick, and
- | a final isolating and wear-protection coating of SICON®; d=3 µm.

Data transfer via Bluetooth

This new, very durable measurement and safety system uses for data transfer a Bluetooth low-energy system which permits contactless data transfer directly from the washer to a mobile device (tablet) at a distance currently up to 40 m away. It can be straightforwardly installed in threaded joints in a wide variety of applications, such as building surveillance or in wind power and production installations, and with its multiple

sensor structures it captures local load distribution both statically and dynamically. In addition, a meander structure of chromium ensures optimal temperature sensing within the thin film system.

Advantages

Compared with standard commercial washer systems the sensorized washer system presents a number of advantages:

- | Static and dynamic acquisition of measurement data over a long period in the form of »condition monitoring«
- | Retightening of threaded joints only when needed—in other words, when a drop in the preload force is detected by the sensorized washer system
- | Improvement in maintenance conditions since there is no need to check threaded joints with a torque wrench
- | Safety and measuring system for threaded joints
- | Universal application
- | Temperature-compensated measurement of forces
- | Production in sizes from M3 to M64
- | Individual designs according to customer requirements
- | Minimum thickness of the base body 0.5 mm
- | Wired as well as wireless data transfer

Technical data for the washer sensor system with Bluetooth low-energy data transmission

- | Calibrated load range 0–10 kN
- | Temperature range 0–50 °C
- | Data acquisition rate <20 Hz
- | Operating time (20 Hz) 24 h
- | Stand-by with active radio link 900 h
- | Range <40 m
- | Accuracy ~1 % of final value
- | USB charger adapter available

Outlook

There is a very wide range of applications for this sensor system. Geometries, the layered structure and measurement data transmission are specially adapted for each individual case. To be best prepared for future applications, the Fraunhofer IST is working on both the modification of structuring and coating processes as well as on the further development of wireless data transmission. The aim is to develop sensor systems which can also be used outdoors. If these systems are to be able to transmit data for long periods even under difficult conditions, such as weathering influences, they must be built more robustly.

1 Sensorized washer with Bluetooth low-energy data transmission.

2 Washer sensor in a threaded joint on a flange cover.

3 Different stages in the production of the washer sensor system.

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