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APPLICATION-SPECIFIC MANUFACTURING OF SENSOR SYSTEMS

The customer request is the focus of sensor developments at the Fraunhofer IST. This involves the geometry of the base body, as well as the type and number of the sensor systems that are combined in a thin-film system. Currently in this regard piezo-resistive and thermo-resistive sensors are available, in which the requirements of the client are appropriately implemented. Several examples are presented in Fig. 1 and Fig. 2.

The manufacturing of the sensory thin-film system

In most cases they are manufactured out of hardened steel and in shape they are reminiscent of washer geometries, which can easily be used to monitor threaded connections. For this, initially with the aid of a PACVD process, a DiaForce® film that was specially developed at the Fraunhofer ST, is deposited. Then individual circular electrode structures are manufactured out of chromium, and these structures form the load measuring sensor surfaces (see Fig. 1 and Fig. 2). Then on a subsequent, electrically-isolating SiCON® intermediate layer, a hydrocarbon coating modified with silicon and oxygen, which likewise is deposited in the PACVD process, conductive traces are structured to contacting points, as well as temperature-measuring meander structures out of chromium. These structures are protected against wear with a second and final SiCON® layer (see Fig. 3).

Sensor characteristics

In test stands of the Fraunhofer IST the temperature-dependent and load-dependent characteristic curves of each individual sensor structure are measured. In the case of piezo-resistive sensors these are characteristic linear resistance dependencies on the load. In this process a full-bridge or half-bridge circuit is established and a constant voltage of 5 V is applied. The thermo-resistive meander structures likewise show linear resistance dependencies. They are structured in a so-called four-wire arrangement; via the outer conductors a constant current of 10 mA, for example, is applied and the voltage change is measured via the inner conductors. Due to the fact that the piezo-resistive DiaForce® sensor film, as an amorphous carbohydrate film, is a semiconductor it has an exponential resistance dependency on temperature. This effect can be compensated through the additional integration of temperature-compensating structures in the contacting area. Sample characteristic curves of a force sensor structure and of a temperature meander are presented in the adjacent diagram.

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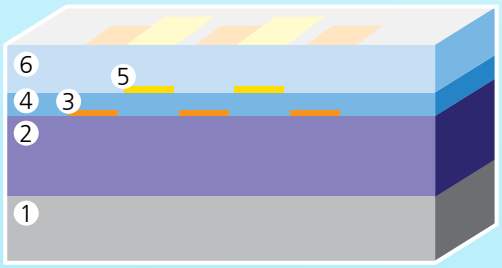

6. Insulating and wear-protection layer (SiCON®)
5. Temperature meander structure
4. Insulating and wear-protection layer (SiCON®)
3. Electrode structure Cr
2. DiaForce®
1. Steel base body

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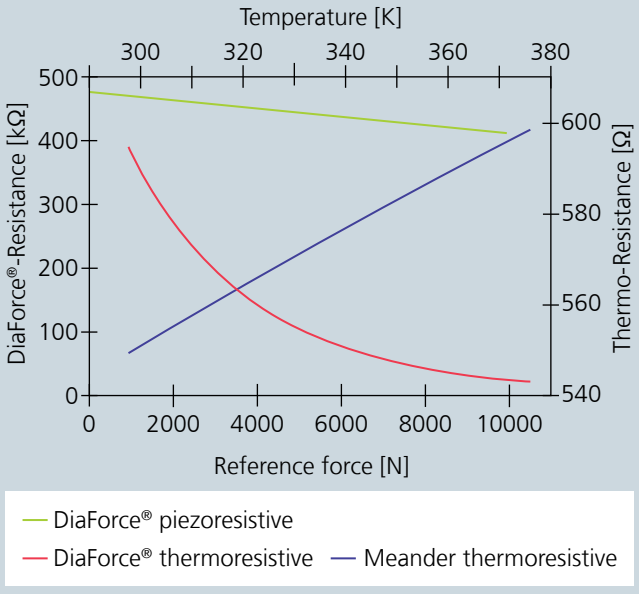
Outlook

In accordance with customer requirements, in the future this should be further developed into sensor systems with wireless data transfer. On the other hand, first and foremost the tasks on the multi-functional film system should be pursued with regard to improved and new sensor integrations.

Load-dependent and temperature-dependent resistance curve of a sensor structure and the linear resistance dependency on the temperature of a meander structure.



1 *Washer-like sensor systems with different sensor arrangements on the surface of a hardened steel substrate.*

2 *Sensor systems with additional wear protection coating (on the right, partially deposited).*

3 *Schematic presentation of the coating system.*

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