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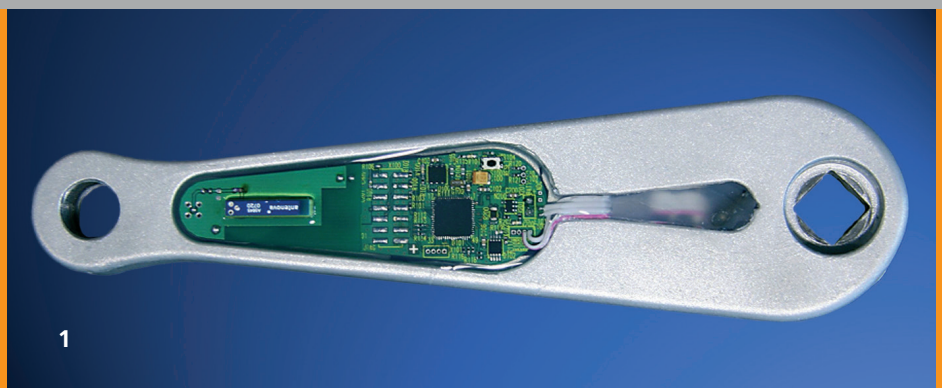

1 *Pressure die-cast pedal crank with integrated piezo sensors for measuring compressive and tensile forces.*

CAST TRONICS®

CASTING TECHNOLOGY-INTEGRATED PIEZO-SENSORS

Fraunhofer-Institute for Manufacturing Technology and Advanced Materials IFAM
Shaping and Functional Materials

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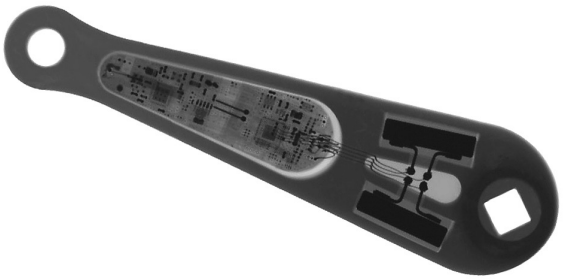
The *CAST*TRONICS® technology enables the in-process integration of electronic and adaptronic functional components during the casting process.
Thus, compared to conventional castings, extended electronic, sensor or actuator functionalities can be introduced.

Demonstrator:
Function-integrated pedal crank

Two integrated piezo-sensors measure the compressive and tensile forces induced in the component during operation of the function-integrated pedal crank. These data are electronically processed, digitalized and wirelessly transmitted to an evaluation system. The particular feature of this pedal crank is that the sensors are directly cast in the component structure and can therefore measure the loads directly in the affected location - in the component structure itself.

The piezo-sensors are directly embedded in the component structure of the pedal crank and are therefore integrated within the component without loss or damage. The integrated electronics are protected against dirt, dust and liquids during manufacturing and installation, as well as in operational use. In addition, the connection of the sensor or actuator elements to the material structure is improved.



Additional machining and joining processes can be omitted through this in-process integration of the functional elements, offering cost reduction potential in the manufacturing of metal components with integrated sensors.

Function principle of piezo sensors

The technical function principle of piezo sensors is based on the piezoelectric effect. Mechanical deformation (for example due to compressive or tensile forces or vibrations) of piezoelectric materials generates electrical charges in the crystal structure and these can be used to derive the sensor signal for the corresponding load. Extremely small response times of several microseconds are realizable. In the reversal of this effect, piezoelectric materials can be actively deformed by the application of an electric voltage.

Application potential

Compressive/tensile force sensors

Component-integrated piezoelectric ceramics offer applications for both sensor and actuator functions. The sensor properties enable detection of mechanical loads in component structures caused by compressive and tensile forces, as well as of oscillations present in the component.

Structure Health Monitoring

Status monitoring of cast components can be realized through the knowledge of loads present in a component. For example, sensor data can be acquired in real time and therefore warn about actual overloading or damage to the component (example: safety components). Alternatively, sensor data can be stored over a specific period of time in order to evaluate the lifecycle of a component to schedule (example: optimized maintenance cycles).

Structure Health Control

The combination of actual load data for a component and the possibility of actively influencing the behavior of a component or its system mean that overloading can be detected and damage avoided (example: active oscillation damping, intervention in component acoustics).

Our Offer

The Casting Technology and Component Development department at Fraunhofer IFAM can support you through the entire process chain of the *CAST*TRONICS® technology:

- Brainstorming and project consultancy
- Selection of piezoelectric ceramics
- Design of insulation materials and geometry
- Concept development for positioning in the mold
- Simulation of the casting process
- Test casting series
- X-ray scanning and computer tomography

You can find further information on our website

www.casttronics.de

2 *X-ray of cast component with embedded sensors.*

3 *Measuring the mechanical load of a pressure die-cast component and wireless transmission of the sensor data.*