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THERMAL MEASUREMENT TECHNIQUES AND SYSTEMS

Electronic tongues can taste the difference

By recognizing patterns in the various sensory signals that the tongue transmits in fractions of a second, the human brain can intuitively distinguish between thousands of different foods. The same approach can also be applied to measurement technology: With the appropriate evaluation methods, a combination of thermal and electrical impedance spectroscopy makes it possible, for example, to reliably recognize the characteristics of liquids used in processes.

At first glance, human sensory capacity and information processing during eating may seem somewhat trivial: The tongue identifies the taste, temperature and quality of food and drink. By combining this information with the sensory impressions provided by the olfactory cells and the visual cells in the retina, humans can reliably distinguish between an incredible number of different foods – those with a practiced palate can even identify individual components of a dish without difficulty. Only upon closer examination does the remarkable performance of the sensory cells and the brain become clear. In order to identify the taste of a food, the brain must combine and evaluate a broad range of sensory signals in a proce ss both highly complex and efficient.

The electronic sensors commonly used today are downright simple in comparison. Fraunhofer IPM is currently developing new sensor concepts based on combined electrical and thermal impedance spectroscopy, which would allow the measuring principle of recognizing materials by taste to be applied to monitoring technical processes.

Measurement techniques acquire a sense of taste

Electrical impedance spectroscopy is a proven tool for measuring the characteristics of liquids that depend on electrical conductivity. However, there is a problem: Due to their size, the measurement structures used are very sensitive with respect to undesirable deposits, which can separate the measurement structures from the liquid. In real processes, such deposits are generally impossible to avoid, which is why Fraunhofer IPM is trying a new approach: Drawing on additional sensors for thermal impedance spectroscopy, these deposits are registered as a change in the thermal contact between the measuring tongue and the liquid.

Combining measurement data creates clarity

But that's not all. Thermal impedance measurement can additionally be used to detect changes in the thermal characteristics of a liquid. Such characteristics are directly linked with other characteristics, such as viscosity. Combining several thermal measurement structures also makes it possible to measure flow rate and direction.

IMPEDANCE SPECTROSCOPY is used to examine a wide range of materials and conductivity mechanisms. In electrical impedance spectroscopy, impedance depends on the frequency of the alternating current. If the thermal conductivity rather than the electrical conductivity of a material is examined, this is known as »thermal impedance spectroscopy«. Combining both methods makes it possible to make more reliable statements about the characteristics of liquids used in processes.

1 *Electronic tongues are designed downright simple if compared to the human tongue.*

Scientists at Fraunhofer IPM are currently developing innovative measurement concepts that combine a wide range of sensors to measure the aging of oils as well as sooting and other processes in chemical reactors. In addition, some measurement structures are being specially furnished with reactive coatings. As with the human brain, the focus is on analyzing and linking the individually detected sensor signals. Because what is true for the human tongue is equally true for the electronic tongue – in order to reach the right conclusion, it is necessary to combine various information about taste. Whether the conclusion is: Yes, the soup has been over salted. Or: Yes, the hydraulic oil needs to be changed.

2 *Novel sensor concepts based a combination of thermal and electrical impedance spectroscopy reliably detect characteristics of liquids.*

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