# Novel sensors to detect molecules for medicine and agrifood

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(Phys.org)—Agribusiness and medicine are constantly seeking more efficient methods for detecting biomolecules. To meet this need, a novel concept of miniaturized sensors has been developed by researchers from LAAS-CNRS and the Université Toulouse III - Paul Sabatier in collaboration with HEMODIA, a company specialized in the development of medical devices. These sensors can measure the concentration in solution of a range of substances such as glucose, lactate and glutamate, which can help in making medical diagnosis or which are of interest in the food processing industry. This device, known as ElecFET, combines, for the first time, an acidity microsensor and an enzyme specific to the molecule studied, placed on the surface of a metal microelectrode. The integration of these two components on an electronic silicon chip at the micrometric scale represents a real technological advance. This work is published on 8 November 2012 in the journal *Biosensors & Bioelectronics*.

ElecFET (electrochemical field effect transistor) technology is based on a chemical reaction between the studied biomolecule and an enzyme of the oxidase family, capable of degrading it. The surface of the microelectrode of the device has an enzyme layer specific to the molecule being analyzed. When the molecule approaches the electrode, the enzyme captures and degrades it. This reaction produces hydrogen peroxide (H2O2), which is then oxidized on the electrode by means of a suitable electrical polarization, which releases hydronium ions, H3O+, and causes increased acidity in the vicinity of the electrode. It is this acidity peak that is detected by the pH microsensor associated with the

device. Thus, as a function of the measured drop in pH, the ElecFET determines the concentration of molecule studied.

Apart from its innovative concept, the ElecFET represents a technological advance because it makes it possible, in an extremely restricted volume (less than one microliter), to degrade the molecule, control the oxidation of the peroxide thereby produced, and measure the associated local variation in pH. To do this, the intricate connection of the electrode and the pH sensor needs to be completed at the micrometric scale. The two components are integrated onto a silicon chip, which ensures that the device is compatible with microelectronics technologies.

The ElecFET allows molecules to be detected over different concentration ranges, extending from the micromole to one mole per liter. The advantage of this system compared to existing technologies lies in the potential control of the reaction: by modifying the polarization of the microelectrode, it is possible to change the detection range of the device and thereby offset potentially insufficient activity of the enzyme used. Tested by the researchers for the detection of glucose, lactate and glutamate, the ElecFET device has demonstrated measurement precision comparable to that of available technologies.

The ElecFET could have numerous applications in medicine and in the food processing industry. For example, the accurate determination of blood glucose levels is vital for diabetic patients. Lactate, which is found in sweat, is a physiological stress marker that indicates an athlete's state of fatigue, for example. Glutamate is a neurotransmitter that excites the central nervous system, and whose continuous analysis is necessary for diagnosing various neurological disorders such as Alzheimer's disease. In the food processing sector, lactate is a marker of all processes based on lactic fermentation, whereas glutamate is an umami taste vector. The range of molecules detected by the ElecFET could potentially be

extended to all enzymes of the oxidase family, opening up numerous application possibilities.

**More information:** Diallo, A.K. et al., Development of pH-based ElecFET biosensors for lactate ion detection, *Biosensors and Bioelectronics*, 40 (2013), p.291-296 DOI: 10.1016/j.bios.2012.07.063