Chemical gas sensors for agri-food water management

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For a sustainable water management is fundamental to obtain differentiated response in terms of selective irrigation, analyzing and evaluating the water content of the soil or the water requirement of the plants. Although the technological science provides several tools and analysis techniques for the remote sensing, a well-structured system has not been widely documented for the parallel evaluation of the soil-atmosphere moisture status and the monitoring of emissions variability of the crops over a whole growing season. In fact, on one side the majority of studies on volatile gases profile in the soil atmosphere, i.e. gas fingerprints, are pointed towards the soil microbial metabolic activity. On the other hand, the monitoring of Volatile Organic Compounds (VOCs) secreted by plants is mainly focused on the control of their health status, which can be affected by insects or disease. For the estimation of VOCs emitted from soil and plants, equipment should be cheap and not bulky, whereas analysis techniques should be easy to perform and not invasive. Starting from this consideration, we adopted an innovative approach lies in designing, developing and validating a technology platform consisting of a proper simple system based on Metal-OXide (MOX) gas sensors for monitoring VOCs emissions from the soil-plant-atmosphere system of intensive crops, i.e. tomato crops, correlated to water content. We were able to collect data in situ from the sowing to the harvest. After a preliminary lab-test with target gases identified by literature, we selected 4 MOX gas sensors to integrate in the dedicated hardware: SnO_2 + Au 2%, SnO_2 + Pt 2%, WO_3, and SnO_2 + Pd 2%, each employed at its best operating temperature, ranging from 350 to 450 °C.
Signal analysis allowed to identify a strong dependence of gaseous emissions on significant events for the crop, such as irrigation and rain, or for its growth evolution. In the last case, it was possible to select one sensing material, which correlates the emissions with the tomato growth. Indeed, SnO_2 + Pt 2% showed a decrease of response up to a constant value when the tomato plants development reached its culmination, after which only the fruits continued their growth. From a technological point of view, the highlighted information may provide irrigation advices about the time of intervention, whereas from a biological point of view it could be possible to investigate the correlation between morphological changes in plants and their water stress, getting at the root cause.

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