

Smart Environmental Monitoring by Low-Power and Self-Powered Gas Sensors and Artificial Intelligence

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With the advent of the physical AI era, there has been a significant rise in the use of advanced sensors in several sectors, including but not limited to smart factories, healthcare, environment, and entertainment. However, the deployment of an increasing number of sensors in IoT systems has made it crucially important but challenging to reduce their form factors and power consumption. Consequently, there is a growing need for sensors that are miniaturized, low-power, or self-powered. In particular, when it comes to environmental IoT, it is essential to decrease power consumption in gas sensors while simultaneously enhancing sensing performance factors, such as sensitivity, selectivity, and response speed. In this talk, we present some recent advancements in the development of environmental sensors that are miniaturized, low-power or self-powered. These sensors utilize functional nanomaterials, microfabricated sensor structures, and photo-activated sensing mechanisms, which were developed by our research group at KAIST. Additionally, we describe the implementation of deep learning-based signal processing techniques for ultra-low power environmental sensors. The following topics are covered in depth: (a) Low-power semiconductor metal oxide (SMO) based chemoresistive gas sensor array using localized hydrothermal synthesis, (b) Ultra-low-power SMO gas sensors monolithically integrated on a micro-LED platform, (c) Self-powered gas sensors using chemo-optically modulating sensing films and photovoltaic cells, (d) Machine learning of gas sensor array for high performance electronic nose (e-nose) systems.

Keywords: Low-power/Self-powered gas sensors, micro-LED gas sensor, machine learning, Electronic nose (E-nose)

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