Pushing the limits; Recent progresses in chemical sensors research

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Semiconductor sensors may be used for varieties of applications, and have advantages of miniaturization and integration for mobile and wearable devices. However, many of the semiconductor sensors suffer from (1) limited sensitivity at room temperature (RT); sensor system requires relatively large power consumption for heating, and (2) lack of selectivity that can distinguish individual target species. Various approaches were taken to improve the limitation of semiconductor sensors, and especially semiconductor sensors based on nanomaterials such as carbon nanotubes and semiconductor nanowires showed potential in highly sensitive sensors working at RT. Yet, nanodevices based on nanomaterials lack reliability and reproducibility, failed to meet criteria for commercialization. In the present study, we show that mechanical scratch can be used to sensitize thin film types of semiconductor materials for RT operation. ZnO or TiO2 thin films were mechanically scratched with diamond powders, and we investigated the chemical components of the scratch using XPS. Interestingly, a scratch mechanically made with diamond powders exhibited change of chemical composition. While ZnO thin film sensor does not show noticeable change of conductance to NO2 or NH3 gases, dramatic change of conductance has observed with mechanically scratched thin films.

In order to resolve the issue of selectivity, machine-learning based algorithms were applied to collection of datasets obtained from multiple sets of individual sensors. By combining sensors with different transduction mechanism with machine learning algorithms, it may be possible to get over issues of selectivity.