# Development of Chemiresistive Ethanol sensors using Nanostructured Metal Oxide/Hydroxide films

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# Abstract

Air pollution is ever-increasing due to industrialization and the uncontrolled release of various gases and volatile organic compounds (VOCs) in the atmosphere, many of which pose health hazards to humans and living creatures. Naturally, to keep ourselves safe, it is important to develop appropriate technologies for environmental air monitoring and subsequent mitigation of the hazards. This thesis derives its motivation from this pretext in which sensors were developed for room temperature monitoring ethanol vapor, a common VOC whose over-exposure to humans has been reported to pose several health threats. Semiconducting materials in nanostructure form are well known to adsorb a large amount of VOC molecules leading to a sharp change in electrical resistance, which in turn can yield a high sensing response against that VOC.

In view of the above, this thesis explores some transition metal oxide/hydroxide for room temperature sensing of ethanol vapor because a large number of existing metal oxide-based VOC sensors operate at higher temperatures (above 200°C), thus somewhat limiting their practical use. The materials chosen in the thesis are all classified under earth-abundant materials and environmentally friendly so that the sensors fabricated using them are safe to use and also low-cost. Although metal hydroxides have many similarities with their oxide counterpart, these have not been well-explored as VOC sensors, and hence in addition to focusing our attention to two very common metal oxides, ZnO and CuO, this thesis also explored a common hydroxide, viz. $Ni(OH)_2$ nanoparticles as ethanol sensor. Since wearable and printable electronics are emerging technologies that will likely change our lives in the near future, this thesis could not ignore their importance. Consequently, a flexible and wearable ethanol sensor has been designed using a wearable fabric as a substrate that has been coated with the CuO nanostructures synthesized in this thesis. The sensor performance of the CuO-coated fabric has been further correlated with the lighting of LEDs connected to a breadboard circuit through a microcontroller.