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Title **Lung Cancer Identification by the Analysis of Exhaled Breath Using Nanomaterial Based Chemical Sensors**

Abstract

Lung cancer is the most common cause of cancer deaths, its global cases are rising, and continuing rises are further predicted. Results of therapeutic interventions are particularly discouraging when the disease is discovered in an advanced stage. Breath sampling is completely noninvasive and provides a potentially useful approach to screen lung cancer at early stages, to avoid metastatic spread, thereby increasing the rate of successful treatment. It is an established fact that the profile of volatile organic compounds is different in patients with lung cancer than in control subjects. New screening methods that are highly sensitive, specific, and fast are needed for early diagnosis, prognosis, monitoring pathogenesis, and targeted therapy. Despite many reports of VOC profiling in lung cancer patients, there is still no reliable method for diagnosing lung cancer at the early stages. In this work SnO_2 was doped different single transition metal (i.e., Cr, Mn, Co, Ni, Cu and Zn) and synthesized by sol gel method. 5 VOCs that are most common biomarkers for lung cancer detection i.e., *Acetone, Ethyl acetate, 1 Propanol, Isopropyl Alcohol* and *Toluene* were chosen for sensing based on their lethal dosage levels. A Screen Printed Electrode of such synthesized nanomaterial was prepared and investigated electrochemically by cyclic voltammetry and electrochemical impedance spectroscopy for the sensing of each VOCs separately. A significant increase in the sensitivity for all the VOC was achieved with doping of different transition metals. Cyclic voltammetry results revealed that each developed sensor is highly selective for a VOC. For acetone and Ethyl acetate Cu doping in SnO_2 showed highest sensitivity with least LOD values whereas in case of 1-Propanol, Isopropyl alcohol, and Toluene highest sensitivity and low LOD value was achieved for Zn-SnO_2. To study the selectivity of the developed sensors, sensitivity was compared for different VOC and it was found that Cr-SnO_2 is highly selective for Isopropyl Alcohol and Mn-SnO_2 is highly selective for 1-Propanol. Repeatability, reproducibility, and stability of the developed sensor was also examined. Relative standard deviation (RSD) was

calculated to obtain the repeatability parameter which was found ~5% which shows that the modified electrode can be easily reproduced. A suitable sensing setup may need to be developed to analyze the breath samples.

These findings suggest that the developed sensor have the potential to detect lung cancer and is highly sensitive, selective, repeatable, and stable. This could eventually lead to noninvasive early detection of lung cancer thus revolutionizing lung cancer treatment whereas more studies are needed in the future.