Title: Modeling the Deposition and Stress Generation in Thin Films for CMOS-Integrated Gas Sensors

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Abstract

The presence of various gases in our vicinity helps to shape our perception of the environment. Although the human nose is a natural sensor for hundreds of different gases, it fails when absolute gas concentrations or odourless gases require detection. Many odourless gases are lethal at relatively low concentrations and their detection can greatly improve our health and safety. The ability to detect these gases electrically is therefore a topic of extensive research useful for a wide range of applications. The fabrication of wearable sensors which can be integrated within always-on mobile technologies such as wristwatches and smart-phones is of added interest. Thus, it is essential that the fabrication of sensor devices fits to a CMOS processing sequence. The sensor integration is possible using a suspended membrane structure with a thin metal oxide film deposited on top of a microheater. Metal oxide structures, especially tin oxide (SnO_2) and Zinc Oxide (ZnO), have recently proven their potential as a gas sensing material which can be cheaply deposited using techniques fitting to the CMOS processing sequence. The films can be deposited using sputtering or spray pyrolysis, with each techniques having its advantages and disadvantages, which are analyzed in this work. Models for both deposition types have been developed and integrated within a process simulator, while the stress evolution in the film, which varies depending on the deposition technique used, is also investigated. The generation of stress during deposition can be caused by stress build-up during the grain formation or during cool-down, when a high temperature deposition technique is implemented. Sputtering is usually performed at low temperatures and stress formation during grain growth is the main cause of stress, while during spray pyrolysis, which is performed at temperatures between 200ºC and 400ºC, the stress develops mainly during the cooling to room temperature after deposition and the stress evolution depends on the coefficient of thermal expansion of the depositing film. In addition, during sensor operation, the metal oxide film must be heated to temperatures between 250ºC and 550ºC, which causes added strain in the sensing film. The influence of the stress on the metal oxide reliability and the sensor performance are discussed in this work.

Biography

Dr. Lado Filipovic studied electrical engineering at Carleton University in Ottawa, Canada. In 2010 he joined the Institute for Microelectronics at the Technische Universität Wien, lead by Prof. Siegfried Selberherr. The main focus of his postdoctoral work is modeling processing techniques and the effects of process variability on semiconductor devices, mainly dealing with smart gas sensors, through silicon vias, and interconnect structures. Prof. Siegfried Selberherr received the degree of Diplomingenieur in Electrical Engineering and the doctoral degree in Technical Sciences from the Technische Universität Wien in 1978 and 1981, respectively. Since 1988 he has been the Chair Professor of the Institute for Microelectronics. From 1998 to 2005 he served as Dean of the Faculty for Electrical Engineering and Information Technology. Prof. Selberherr published more than 350 papers in journals and books. He and his research teams achieved more than 1000 articles in conference proceedings of which more than 150 have been with an invited talk. Prof. Selberherr authored two books and co-edited more than 30 volumes, and he supervised, so far, more than 100 dissertations. His current research interests are modeling and simulation of problems for microelectronics engineering.