of the substrate species into the films. The developed novel process can be utilized for integration of electronic ceramic films with ULSI technology in designing new generation semiconductor devices.

doi: 10.1016/j.ceramint.2004.03.013

Epitaxial metal oxide thin film heterostructures for tunable chemical sensors

X.Q. Pan[a,*], J.E. Dominguez[a], W.W. Kim[a], A. Allenic[a], S.J. Wang[b]
[a]*Department of Materials Science & Engineering, University of Michigan, Ann Arbor, MI 48109, USA*
[b] *Institute for Materials Science and Engineering, Singapore 119260, Singapore*
* Corresponding author.

Thin film sensors based on oxide heterostructures have an advantage over conventional chemical sensors in terms of lower cost, lower power consumption, lower weight, and faster response. In this paper, we present our recent studies on the epitaxial SnO_2/TiO_2 and SnO_2/Cr_2O_3 heterostructures deposited on the sapphire and TiO_2 substrates by a femtosecond pulsed laser deposition. We have successfully synthesized epitaxial oxide heterostructures consisting of p–n junctions. It was found that the electrical properties and gas sensitivities of the epitaxial heterostructures can be tuned by chemical doping in oxide and by electrical bias across the p–n junctions. We also found that the electrical transport properties of semiconductive oxide multilayers strongly depend on the layer thickness and the structure of the heterojunctions. This study suggests that epitaxial metal oxide heterostructures with p–n junctions could make a new avenue for the development of selective, tunable chemical sensors.

doi: 10.1016/j.ceramint.2004.03.014

Control of microporous structure for semiconductor gas sensor

N. Yamazoe
Faculty of Engineering Sciences, Kyushu University, Kasuga-shi, Fukuoka 816-8580, Japan
Tel.: +81-92-583-7538; fax: +81-92-583-7537.
E-mail address: yamazoe@mm.kyushu-u.ac.jp
(N. Yamazoe).

Oxide semiconductor gas sensors detect a target gas (analyte) from a change in electrical resistance. Thanks to extensive R&D effort to data, this type of sensor has grown to be produced in a massive scale for various applications such as gas leakage alarms, CO detectors, breath checkers, auto dampers, alcohol checkers and so on. Yet, there are many kinds of gases else, which are desired to be targeted for sensor detection, including volatile organic compounds (VOCs), endocrine disrupting chemicals (EDCs), and bio- or food-related various gases. Most of these gases are present at small concentrations, so that the relevant sensors are required to have very high sensitivity. High-sensitivity design seems to be one of the most urgent research subjects for semiconductor gas sensors.

From a basic viewpoint, it has been recognized that the receptor function of this type of sensor is provided by the surface of oxide grains or a foreign substance (sensitizer) dispersed on them, while the transducer function is by the grain boundaries. However, this scheme ignores microstructure of polycrystalline devices except that it predicts that unusual situation arises when the grain size becomes smaller than twice the thickness of the surface space charge layer of grains. The importance of microstructure or microporous structure is made evident when one considers that gaseous molecules diffuse in the polycrystalline device, while if inflammable, they are consumed by the reaction with the surface oxygen of the grains. Based on a simple diffusion–reaction equation, sensor response (sensitivity) at steady state for a thin film device can be formulated under simplifying assumptions to be linear to $(1/m)\tanh m$, where $m = L(k/D_k)^{1/2}$ and L is the film thickness, k the first order reaction rate constant and D_k Knudsen diffusion constant. Thus, S becomes larger when m is small (<1), or, in other words, when the device has open structure (large D_k and small L). The control of microporous structure is therefore decisively important for designing a high sensitivity sensor, beside exploration for sensitizers. Some examples of recent studies will be introduced to demonstrate the importance of microporous structure control.

doi: 10.1016/j.ceramint.2004.03.015

Bio-inspired processing of electroceramic thin films and micropatterning

K. Koumoto*, Y. Masuda, Yanfeng Gao
Department of Applied Chemistry, Nagoya University, Nagoya 464-8603, Japan
* Corresponding author. Tel.: +81-52-789-3327;
fax: +81-52-789-3201.
E-mail address: g44233a@nucc.cc.nagoya-u.ac.jp
(K. Koumoto).

There has been a growing interest recently in “bio-inspired” or “bio-mimetic” approaches to prepare ceramic thin films at ambient temperatures in solutions, as they are expected to enable us to develop novel processing methods and manufacturing processes that are low cost and environment-friendly. Conventional lithography technology is facing many problems, and alternative novel technology is intensely required to overcome the present issues and to better match the future nanotechnology. Bio-inspired processing