DIPARTIMENTO DI SCIENZE MATEMATICHE E INFORMATICHE, SCIENZE FISICHE E SCIENZE DELLA TERRA
Dottorato di Ricerca in Fisica

Appunti di Fisica '24

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Sala Seminari, CNR-IPCF

Nanostructured Sensing Materials for Environmental Monitoring and Industrial Applications

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Chair: Giuseppe Calogero

The role of gases and the measurement of their concentration have always received widespread applications in many fields of science and technology. For example, homeland security and defense applications need effective portal monitoring for chemical weapons sensing; devices that can serve as personal exposure monitors, providing advance warning of food spoilage, and enabling breath analyzers to uncover pre-symptomatic disease, are also in demand; small scale solid-state sensors, which present high stability in harsh ambient, are also of great interest for vehicle emission control and environmental monitoring because of increasing demands on emission control legislations. These applications pose many challenges, because they require devices with high levels of sensitivity and selectivity, in small, economical packages.

Resistive gas sensors based on Metal Oxide Semiconductors (MOS) are among the most studied and widely applied. Even if they initially suffered of some technical problems such as the low capability to discriminate among different gases (selectivity) and low long-term stability, the continuous progress of the microelectronic technologies together with the developments in material science have overcome these initial limits.

The demand for high performance gas sensors with better sensitivity and selectivity, faster response, together with low power consumption and high device reliability, generated intensive efforts in order to develop new sensing materials. Nanostructured materials, having dimension in the nanometer scale, display peculiar electrical properties which can contribute to the development of high performances chemical sensors. In fact, the same material having different size and/or shape often shows an increasing of the sensing performance because of the much larger surface-to-bulk ratio in nanomaterials compared to coarse micrograined materials. The sensing layer particles size reduction allows an enhancement of some functional characteristics of gas sensors, such as sensitivity and response/recovery time. Therefore, the gas

sensing efficacy of MOS sensors increases drastically when the sensing layer is in a nanostructured form.

In this presentation results obtained, mainly focused on the synthesis and characterization of different nanomaterials, as well as their use in the development of gas sensors for applications in the field of environment and energy, are reported and discussed. In particular, great attention was devoted to the study and the optimization of the sensor parameters (operating temperature, response and recovery time) on several nanostructured sensing material for monitoring of toxic or combustible gaseous species (e.g., CO, NOx, H_2, CO_2, hydrocarbons etc.).