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Part 56: Test method for characteristics of MEMS metal oxide semiconductor (MOS) type gas sensor**

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Draft	Report on voting
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Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

– reconfirmed,

– withdrawn, or

– revised.

INTRODUCTION

Micro-electromechanical systems (MEMS) metal oxide semiconductor (MOS) type gas sensor is one of key components in MEMS technologies including chemical MEMS and bio-MEMS. MEMS MOS type gas sensor, in general, consists of MEMS structure with membrane for thermal isolation, microheater for controlling operation temperature, insulator layer between microheater and microelectrode, and microelectrode for measuring resistance change of gas sensing materials on microelectrode. It is possible to detect specific gas or measure the gas concentration by using highly sensitive and selective gas sensing materials.

Micro-electromechanical systems (MEMS) metal oxide semiconductor (MOS) gas sensors represent a significant advancement in the field of gas detection technology. These sensors leverage the integration of MEMS technology with the gas-sensitive properties of metal oxide semiconductors to offer a compact, efficient, and highly sensitive solution for detecting a wide range of gases. MEMS technology enables the miniaturization of gas sensors, enabling them to be manufactured on a microscopic scale with high precision and at a lower cost. The use of metal oxide semiconductors, such as tin oxide (SnO_2), zinc oxide (ZnO), or titanium dioxide (TiO_2), provides the sensor with the ability to detect various gases through changes in electrical resistance when exposed to target gases like hydrogen disulfide (H_2S), carbon monoxide (CO), nitrogen dioxide (NO_2), or volatile organic compounds (VOCs). The combination of MEMS and MOS technologies results in sensors that are not only small and portable but also exhibit fast response times, low power consumption, and high sensitivity. These attributes make MEMS MOS gas sensors ideal for applications in environmental monitoring, industrial safety, automotive exhaust control, and indoor air quality management. As the demand for more efficient and accurate gas detection increases, MEMS MOS gas sensors are positioned to play a critical role in future sensor technology, offering reliable performance in a wide range of environmental conditions. Figure 1 below illustrates a typical MEMS MOS type gas sensor structure as an example. Figure 1 includes the key components shown.

– Membrane for thermal isolation layer: The thermal isolation layer is typically membrane layer such as SiNx, SiO_2 or hybrid layer with SiNx and SiO_2, etc.

– Microheater: The microheater with pad for interconnection is embedded within the MEMS structure. When electrical current passes through microheater, it generates heat due to resistive heating.

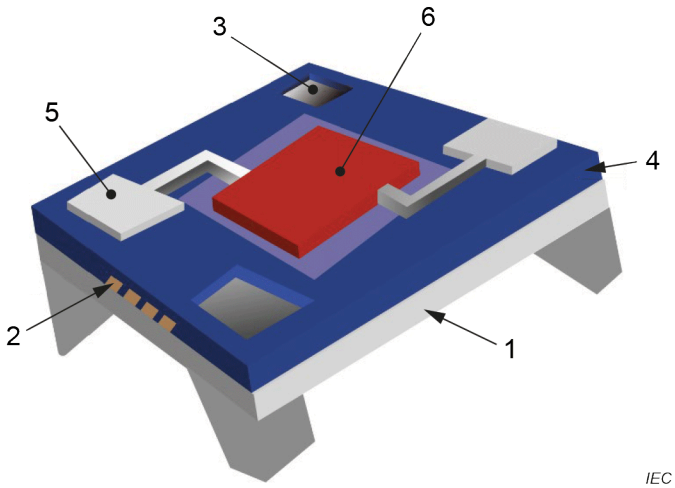
– Pad for microheater: The microheater pad is an element of the MEMS MOS type gas sensor. It is responsible for maintaining the sensor at an optimal operating temperature. The MOS layer requires a specific temperature to interact effectively with gas molecules, which the microheater pad provides by generating heat uniformly across the sensing area. This heating ensures that the sensor responds quickly and accurately to the presence of target gases.

– Insulation layer: The insulator is the material surrounding the microheater. The primary function of insulator is to electrically isolate microheater and MOS gas sensing materials, preventing unwanted electrical currents from interfering with the operation of gas sensor.

– Microelectrode and Pad: The microelectrode and pads for microelectrode are for measuring the electrical signals from the MOS gas sensing materials. Those can be made from materials that ensure good electrical conductivity and strong adhesion to the MEMS substrate.

– MOS Gas Sensing Materials: The sensing materials are typically of two types, n-type MOS, such as SnO_2, ZnO, TiO_2, etc., and p-type MOS such as Co_3O_4, NiO, CuO, etc. When target gases interact with the gas sensing material, its electrical resistance changes. These changes are detected by the electrode and its pads and processed to detect specific target gases and determine the concentration of the target gases. The choice of MOS gas sensing material depends on the specific gases to be detected.

A photograph of fabricated MEMS MOS type gas sensor as an example is shown in Figure A.1.



Key

1 Membrane for thermal isolation layer

2 Microheater

3 Pads for microheater

4 Insulation layer

5 Pads for microelectrode for MOS gas sensing materials

6 MOS gas sensing materials

Figure 1 – Schematic illustration of MEMS MOS type gas sensor

1 Scope

This part of IEC 62047-56 specifies the requirements and test method for characteristics of MEMS metal oxide semiconductor (MOS) type gas sensor.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62047-1, *Semiconductor devices - Micro-electromechanical devices - Part 1: Terms and definitions*

IEC 60079-29-1, *Explosive atmospheres - Part 29-1: Gas detectors - Performance requirements of detectors for flammable gases*

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