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INTERNATIONAL STANDARD

Semiconductor devices – Micro-electromechanical devices – Part 48: Test method for determining solution concentration by optical absorption using MEMS fluidic device

colour inside

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IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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SEMICONDUCTOR DEVICES – MICRO-ELECTROMECHANICAL DEVICES –

Part 48: Test method for determining solution concentration by optical absorption using MEMS fluidic device

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The text of this International Standard is based on the following documents:

Draft	Report on voting
47F/466/FDIS	47F/472/RVD

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.

A list of all parts in the IEC 62047 series, published under the general title *Semiconductor devices – Micro-electromechanical devices*, can be found on the IEC website.

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- reconfirmed,
- withdrawn, or
- revised.

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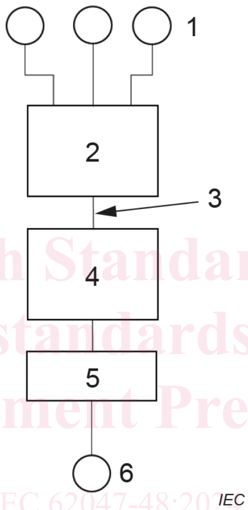
INTRODUCTION

A MEMS fluidic device is one of the key devices in MEMS technologies, including bio-MEMS, chemical MEMS, and micro TAS (total analytical system). A MEMS fluidic device, in general, consists of several micro components such as inlet ports for injection of a filtered sample and reagents to induce a sample to have the optical absorption at specific wavelength, a microfluidic mixer for physical mixing, a micro-reactor for chemical or biological reaction, a detection area for determining the concentration of solution using optical source and detector from the outside, as well as outlet ports for waste-out as shown in Figure 1. All components in a MEMS fluidic device are connected with microfluidic channels. In case there is a synthesizing solution with absorption at a specific wavelength in a MEMS fluidic device, it is possible to determine the concentration by using an absorption method at specific absorption wavelength based on the Beer-Lambert law [1][1]. MEMS fluidic devices are more cost-effective than conventional analysis tools and methods since expensive reagents and human power are used less and in-situ monitoring is enabled.



Key

1 inlet ports

2 microfluidic mixer

3 microfluidic channel

4 micro-reactor

5 detection area

6 outlet port

Figure 1 – Schematic drawing of micro components in a MEMS fluidic device (top view)

[1] Numbers in square brackets refer to the Bibliography.

SEMICONDUCTOR DEVICES – MICRO-ELECTROMECHANICAL DEVICES –

Part 48: Test method for determining solution concentration by optical absorption using MEMS fluidic device

1 Scope

This part of IEC 62047 specifies the requirements and testing method to determine the solution concentration by optical absorption using MEMS fluidic device.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
microfluidic mixer
MEMS fluidic device for mixing more than two liquid samples in microfluidic channel and chamber

3.2
MEMS fluidic channel
microfluidic channel
channel in sub-micron or micron dimension to deliver liquid or gas, fabricated usually by micromachining or MEMS techniques

4 Test method

4.1 General

4.1.1 Principle of the absorption method

The principle of the absorption method for determining the concentration of a solution is based on the Beer-Lambert law. As shown in Figure 2, Beer-Lambert law relates the optical attenuation of a physical material containing a single attenuating species of uniform concentration to the optical path length through the sample and absorptivity of the species with the following Formula (1):

$$A = -\log T = \log(1/T) = a \cdot b \cdot c \qquad (1)$$

where:

A is the absorbance, expressed as a ratio;

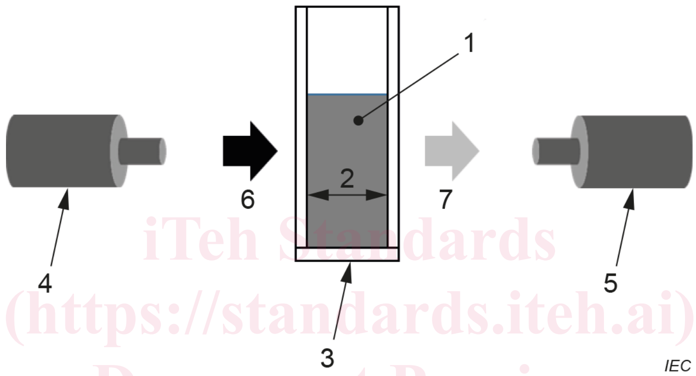
T is the transmittance, expressed as the ratio of transmitted intensity to the incident intensity = I/I_0;

a is the molar absorption coefficient, expressed in per molar concentration per optical path length (in $M^{-1}cm^{-1}$);

b is the optical path length (in cm);

c is the molar concentration (in M).

Based on the Beer-Lambert law, the molar concentration, c (in M), is calculated as a function of the molar absorption coefficient, a (in $M^{-1}cm^{-1}$), optical path length b (in cm), and absorbance A (ratio), with these parameters being given or measured at a specified temperature (in °C) for the MEMS fluidic device.



Key

1 specimen (solution) with molar concentration, c

2 optical path length, b

3 cuvette

4 optical source (laser)

5 optical detector (photodiode)

6 incident intensity, I_0

7 transmitted intensity, I

Figure 2 – Optical absorption method for determining the concentration of the solution using a conventional cuvette (side view)

Figure 3 presents a graph where the x-axis is the concentration c (in M) and the y-axis is the absorbance A. For a molar concentration under 10^{-3} M, Formula (1) is linear.

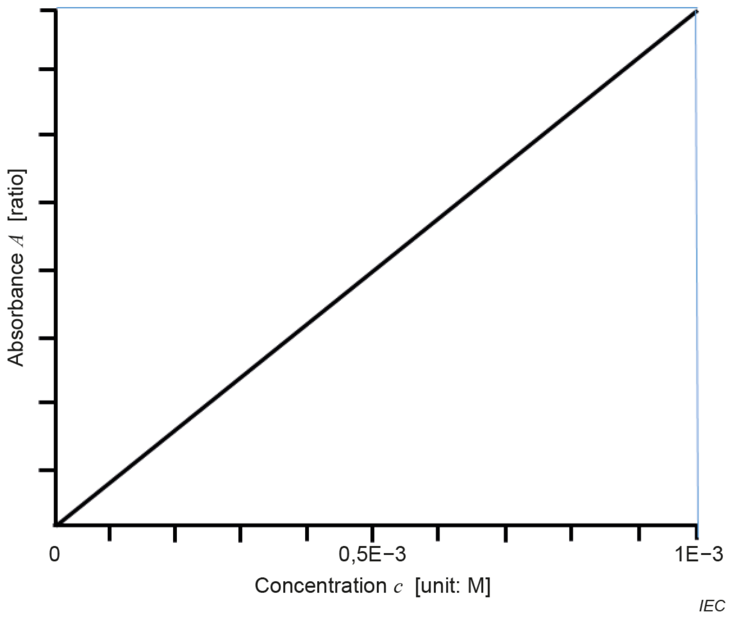


Figure 3 – Schematic graph with the x-axis as the concentration, *c* and the y-axis as absorbance *A*

4.1.2 Molar absorption coefficient, *a*

The molar absorption coefficient or molar attenuation (or extinction) coefficient is a measurement of how strongly a chemical species absorbs, and thereby attenuates, light at a given wavelength. The unit of molar absorption coefficient is $M^{-1}cm^{-1}$ [1]. The molar absorption coefficient is calculated using $a = A/bc$, derived from Formula (1) in advance by measuring the intensity of the incident and transmitted light for a solution whose the concentration, c, is known. The calculated molar absorption coefficient shall be recorded in the test report.

4.1.3 Optical path length, *b*

The optical path length is the length for the incident light to pass through the solution in the MEMS fluidic channel. The unit of optical path length is cm. The measured optical path length shall be recorded in the test report.

4.1.4 Absorbance, *A*

The absorbance of the solution is related to the transmittance, the ratio of transmitted intensity to the incident intensity in Formula (1). The measured absorbance shall be recorded in the test report.

4.1.5 Surface temperature of MEMS fluidic device

Because the solution concentration depends on the surface temperature of the MEMS fluidic device, the measured surface temperature of the MEMS fluidic device shall be recorded in the test report.

4.1.6 Molar concentration, *c*

Molar concentration is a measure of the concentration of a chemical species, in particular of a solute in a solution, in terms of the amount of solution per unit volume of solution [1]. The unit of molar concentration is M. The calculated molar concentration based on Formula (1) shall be recorded in the test report.