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Semiconductor devices - Micro-electromechanical devices - Part 1: Terms and definitions (IEC 62047-1:2005)

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Semiconductor devices - Micro-electromechanical devices Part 1: Terms and definitions
(IEC 62047-1:2005)

Dispositifs à semiconducteurs -
Dispositifs microélectromécaniques
Partie 1: Termes et définitions
(CEI 62047-1:2005)

Halbleiterbauelemente -
Bauteile der Mikrosystemtechnik
Teil 1: Begriffe und Definitionen
(IEC 62047-1:2005)

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Foreword

The text of the International Standard IEC 62047-1:2005, prepared by IEC TC 47, Semiconductor devices, was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 62047-1 on 2006-06-01 without any modification.

The following dates were fixed:

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Endorsement notice

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Partie 1: Termes et définitions

Semiconductor devices – Micro-electromechanical devices –

Part 1: Terms and definitions

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR DEVICES –
MICRO-ELECTROMECHANICAL DEVICES –

Part 1: Terms and definitions

FOREWORD

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International Standard IEC 62047-1 has been prepared by IEC technical committee 47: Semiconductor devices.

The text of this standard is based on the following documents:

FDIS	Report on voting
47/1821/FDIS	47/1840/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 62047 consists of the following parts, under the general title *Semiconductor devices – Micro-electromechanical devices*:

Part 1: Terms and definitions

Part 2: Tensile testing methods of thin film materials (in preparation)

Part 3: Thin film standard test piece for tensile testing (in preparation)

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

SEMICONDUCTOR DEVICES – MICRO-ELECTROMECHANICAL DEVICES –

Part 1: Terms and definitions

1 Scope

This part of IEC 62047 defines terms for micro-electromechanical devices including the process of production of such devices.

2 Terms and definitions

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

2.1 General terms

2.1.1
micro-electromechanical device
microsized device, in which sensors, actuators, mechanical components and/or electric circuits are integrated

2.1.2
MEMS
microsized electromechanical systems, in which sensors, actuators and/or electric circuits are integrated on a chip using a semiconductor process

NOTE MEMS is an acronym standing for "micro-electromechanical systems". The term MEMS is mostly used in the United States. In general, this term means technologies to realize microstructures, sensors, and actuators by using silicon process technology, though it is occasionally used in some other meanings.

2.1.3
MST
technologies to realize microelectrical, optical and machinery systems and even their components by using micromachining

NOTE MST is an acronym standing for microsystem technologies. The term MST is mostly used in Europe.

2.1.4
micromachine
miniaturized devices the components of which are several millimeters or smaller in size, or a microsystem that consists of an integration of such devices

NOTE The term 'micromachine' has a broad sense from a functional device such as sensor that utilizes the micromachine technology to a completed system. A molecular machine called a nanomachine is also included. Such industrial applications are expected as inspection and repair systems for piping or confined spaces, and micro-factories, which consume less energy. In the medical field, micromachines are expected to replace ordinary surgery by less invasive treatment from the inside of the body. Research and development for the realization of micromachines is divided into two approaches: micro-electromechanical systems (MEMS) using semiconductor manufacturing processes, and miniaturization of the existing machine technologies.

2.1.5
micromachine technology
technology relating to micromachines

NOTE Micromachine-related technologies are extremely diversified. In the fundamental technology field, micromachine technologies include: design, material, processing, functional element, system control, energy supply, bonding and assembly, electrical circuit, and evaluation as well as micro-science and engineering such as thermodynamics and tribology in a microscale. Micromachine technologies have two aspects: technologies required to realize micromachines, and technologies required to apply such technical seeds to other industrial fields.

2.2 Terms relating to science and engineering

2.2.1
micro-science and engineering
science and engineering for the microscopic world of micromachines

NOTE When mechanical systems are miniaturized, various physical parameters change. Two cases prevail: 1) these changes can be predicted by extrapolating the changes of the macro-world, and 2) the peculiarity of the microscopic world becomes apparent and extrapolation is not possible. In the latter case, it is necessary to establish new theoretical and empirical equations for the explanation of phenomena in the microscopic world. Moreover, new methods of analyses and syntheses to deal with engineering problems must be developed. Material science, fluid dynamics, thermodynamics, tribology, control engineering, and kinematics can be systematized as micro-sciences and engineering supporting micromechatronics.

2.2.2
scale effect
changes of various effects on the objects behaviour or the properties caused by the change of the object's dimension

NOTE The volume of an object is proportional to the third power of its dimension, while the surface area is proportional to the second power. As a result, effect of surface force becomes larger than that of the body force in the microscopic world. For example, the dominant force in the motion of microscopic object is not the inertial force but the electrostatic force or viscous force. Material properties of microscopic objects are also affected by the internal material structure and surface, and, as a result, characteristic values are sometimes different from those of bulks. Frictional properties in the microscopic world also differ from that in the macroscopic world. Therefore, those effects must be considered cautiously while designing a micromachine.

2.2.3
mesotribology
tribology applying to the intermediate mesoscopic area between the microscopic world and the macroscopic world

NOTE Tribology deals with friction and wear in the macroscopic world. On the other hand, two major topics of microtribology research are the investigation of tribology phenomena on an atomic or molecular scale, and the quantification of characteristics in friction or wear. If the macro-characteristics generated on both surfaces undergoing relative motion are traced to where they originate, the minimum unit of the atomic or molecule cluster causing those characteristics is reached. Observation on a finer scale reaches a boundary at which these characteristics disappear. Mesotribology pursues new developments on the micro-macro boundary by bringing together atoms on a subnanometer scale to create a mesoscopic scale and investigating the tribological phenomena on this scale.

2.2.4
microtribology
tribology for the microscopic world of micromachines

NOTE Tribology deals with friction and wear in the macroscopic world. On the other hand,when the dimensions of components such as those in micromachines become extremely small, surface force and viscous force become dominant instead of gravity and inertial force. According to Coulomb's law of friction, frictional force is proportional to the normal load. In the micromachine environment, because of the reaction between surface forces, a large frictional force occurs that would be inconceivable in an ordinary scale environment. And very small quantity of abrasion that would not become a problem in an ordinary scale environment can fatally damage a micromachine. Microtribology research seeks to reduce frictional forces or to discover conditions that are free of friction, even on an atomic level. In this research, phenomena that occur with friction surfaces or solid surfaces at from angstrom to nanometer resolution are observed, or analysis of interaction on an atomic level is performed. These approaches are expected to be applied in solving problems in tribology for the ordinary scale environment as well as for the micromachine environment.

2.2.5
biomimetics
creating functions that imitate the motions or the mechanisms of organisms

NOTE In devising microscopic mechanisms suitable for the micromachines, the mechanisms and structures of organisms that have survived severe natural selection may serve as good examples to imitate. One example is the microscopic three-dimensional structures that were modelled after the exoskeletons and elastic coupling systems of insects. In exoskeletons, hard epidermis is coupled with an elastic body, and all movable parts use the deformation of the elastic body to move. The use of elastic deformation would be advantageous in the microscopic world to avoid the friction. Also, the exoskeleton structure equates to a closed link mechanism in kinematics and has the characteristic that some actuator movement can be transmitted to multiple links.

2.2.6
ciliary motion
coordinated motion of multiple cilia

NOTE Progressive waves are generated by coordinated motion of multiple cilia, which is used to transfer fluid or tiny particles, or are used to propel a microscopic organism itself. An example of the former is the ejection of microscopic waste from human tracheae, and of the latter is the swimming of unicellular organisms, such as paramecium. By imitating these ciliary motions, actuators with many artificial cilia have been fabricated by micromachining.

2.2.7
self-organization
organization of a system without any external manipulation or control, where nonequilibrium structure emerges spontaneously due to the collective interactions among a number of simple microscopic objects or phenomena

2.3 Terms relating to material science

2.3.1
shape memory polymer
resin that can recover its primary shape after being deformed when it is heated or receives any other stimuli

NOTE To have the shape memory property, a resin has to have mixed domains of the bridged or partially crystallized fixed phase and the reversible phase. Memorizing and restoring a shape takes the following steps. The resin is kept above a specific temperature to soften both the fixed and reversible phases. Then, holding the resin in one shape (primary shape), temperature is lowered to freeze the fixed phase while the reversible phase is kept soft, thereby storing memory of the primary shape. Then the resin is deformed to another shape (secondary shape) by external force, and cooled further to freeze the reversible phase and keep the secondary shape. In this state, the secondary shape is retained even if the external force is removed. The stored primary shape is restored if the resin is heated to the temperature at which only the reversible phase softens. Since restoration shape is enabled by softening by heat, the generated force is limited. Some resins recover shape not by heat but by changes in pH, electrical stimuli, or light stimuli. Shape memory resins are made of polyester, polyurethane, styrene butadiene, polynorbornane, transpolyisoprene, and so on.