
**Fine bubble technology — General
principles for usage and measurement
of fine bubbles —**

**Part 1:
Terminology**

*Technologie des fines bulles — Principes généraux pour l'utilisation et
la mesure des fines bulles —*

Partie 1: Terminologie



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by ISO/TC 281, *Fine bubble technology*.

A list of all the parts in the ISO 20480 series can be found on the ISO website.

Introduction

Applications of fine bubble technologies can be found in cleaning, environmental improvement, the food and drink sector, aeration systems, medicine, water and waste water treatment, as well as agriculture and aquaculture. Developing appropriate terminology for such diverse technologies is therefore critical to business trade or product acceptance by consumers.

Fine bubbles can be present in both liquids and solids. Fine bubbles can contain air or another gas. The bubble can be held in place by surface tension or be surrounded with a coating, e.g. a lipid. Fine bubbles generated for various applications can vary in size, gas content or bubble coating. The generation techniques used are also different.

It should be noted that the motion of bubbles in a medium can be determined by buoyancy forces or randomly and thermally activated processes leading to Brownian motion. For this reason, larger bubbles can display buoyant behaviour (rise upwards) and smaller bubbles remain in the liquid medium displaying random motion. This document focuses on the definitions of such entities.

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Fine bubble technology — General principles for usage and measurement of fine bubbles —

Part 1: Terminology

1 Scope

This document specifies terminology and definitions used in the area of fine bubble technology. Terminology in this document covers general principles, measurements, and individual applications of fine bubble technology.

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 terminological databases for use in standardization at the following addresses:

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

3.1

bubble

gas in a medium enclosed by an interface

3.2

fine bubble

bubble (3.1) with a volume equivalent diameter (3.8) of less than 100 µm

Note 1 to entry: 100 µm is also represented as 1×10^{-4} m.

Note 2 to entry: [Annex A](#) provides further information on the use of terms “fine bubble” or “ultrafine bubble” (3.3), instead of “nanobubble”.

3.3

ultrafine bubble

fine bubble (3.2) with a volume equivalent diameter (3.8) of less than 1 µm

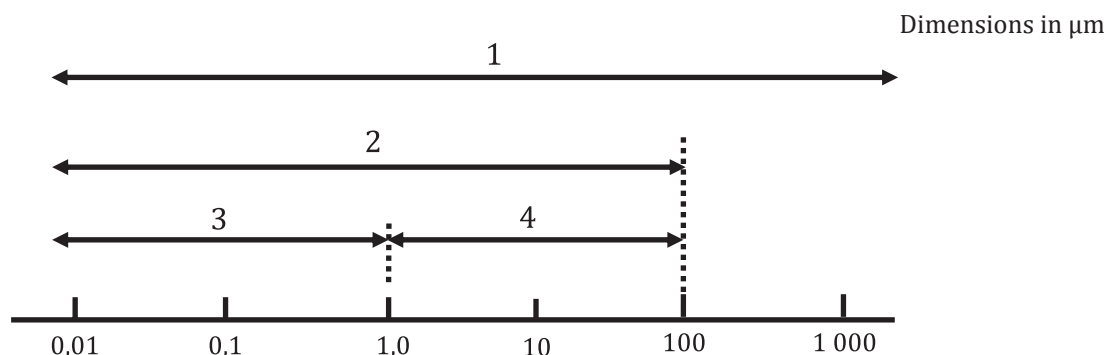
Note 1 to entry: Measured examples of ultrafine bubbles in water by particle characterization methods, in practical application fields, mostly range between 100 nm and 200 nm. The measured results can include contaminants, as well as ultrafine bubbles.

3.4

microbubble

fine bubble (3.2) with a volume equivalent diameter (3.8) in the range from equal or greater than 1 µm to less than 100 µm

Note 1 to entry: [Figure 1](#) shows the size range of *bubbles (3.1)*, fine bubbles, *ultrafine bubbles (3.3)*, and microbubbles.

**Key**

- 1 bubble
- 2 fine bubble
- 3 ultrafine bubble
- 4 microbubble

Figure 1 — Scale diagram showing bubble diameters

3.5**solid medium**

material in solid phase in which *bubbles* (3.1) are dispersed

Note 1 to entry: A solid medium can be a congealed or chemically immobilized (solidified) liquid which contains bubbles. As a result, bubbles are immobilized or have a restricted degree of mobility.

3.6**liquid medium**

material in liquid phase in which the *bubbles* (3.1) are dispersed

3.7**bubble number concentration**

number of *bubbles* (3.1) per unit volume of medium

Note 1 to entry: The medium can be *solid medium* (3.5) or *liquid medium* (3.6).

3.8**volume equivalent diameter**

d_{eq}
diameter of the spherical bubble of equivalent volume

$$d_{eq} = \sqrt[3]{\frac{6}{\pi} V_{bubble}}$$

where V_{bubble} is the volume of the considered bubble

3.9**bubble volume**

spherical (or otherwise) volume of a *bubble* (3.1)

Note 1 to entry: In case of a bubble covered by its *bubble shell* (3.10), the volume of the bubble shell should be included.

3.10**bubble shell**

object or a collection of objects that cover the *bubble* (3.1) surface almost completely

3.11**bubble temperature**

temperature at which an infinitesimal amount of vapour is in equilibrium with a bulk liquid for a specified pressure

[SOURCE: ISO 20765-2:2015, 3.2, modified — Note 1 to entry and Note 2 to entry have been deleted.]

3.12**bubble-point pressure**

pressure under which gas bubbles form in a liquid at a particular operating temperature which gas bubbles (3.1) form

[SOURCE: ISO 15156-2:2015, 3.2]

3.13**coalescence**

action by which bubbles (3.1) in suspension unite to form larger bubbles

[SOURCE: ISO 29464:2011, 3.1.24, modified — “liquid particle” has been changed to “bubbles”.]

3.14**bubble stability**

duration for total volume of bubbles in dispersion to increase twofold or reduce by half under a given temperature and pressure conditions

3.15**bubble size stability**

duration for a *volume equivalent diameter* (3.8) of a bubble (3.1) to increase twofold or reduce by half under given temperature and pressure conditions

3.16**bubble number stability**

duration for the number of bubbles to increase twofold or reduce by half under a given temperature and pressure conditions

3.17**bubble generating system**

system for creating bubbles (3.1) in a liquid medium (3.6)

3.18**fine bubble generating system**

system for creating fine bubbles (3.2) in a liquid medium (3.6)

3.19**ultrafine bubble generating system**

system for creating ultrafine bubbles (3.3) in a liquid medium (3.6)

3.20**number concentration index**

quantity representing the concentration of objects in a fine bubble dispersion measured by an industrially available and agreed method

Note 1 to entry: Fine bubble dispersion in reality often contains not only fine bubbles but also other components with application-specific functions.

3.21**size index**

quantity representing an object size in a fine bubble dispersion measured by an industrially available and agreed method

Note 1 to entry: Fine bubble dispersion in reality often contains not only fine bubbles but also other components with application-specific functions.

Annex A **(informative)**

Use of the terms “fine bubble” or “ultrafine bubble”, instead of “nanobubble” in ISO/TC 281 documents

ISO/TC 281 recognizes that the term “nanobubble” is commonly used to mean “ultrafine bubble”. However, “nanobubble” is not defined clearly, and thus the use of “ultrafine bubble” is strongly preferred.

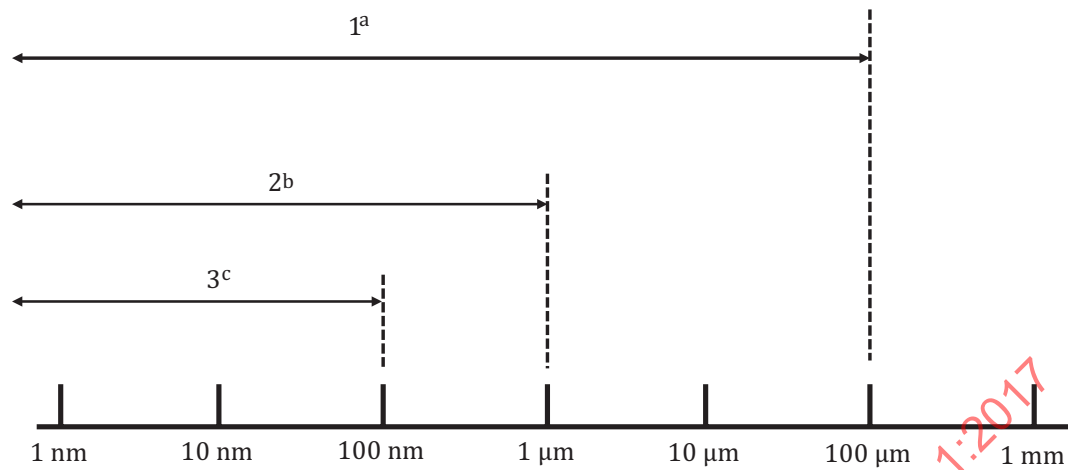
The measurement and characterization of ultrafine bubbles became possible comparatively recently. Ultrafine bubbles are not visible to the naked eye. ISO/TC 229 defines nano-objects as having a size less than 100 nm. Ultrafine bubbles are defined with the size range of 1 µm to a few nm. The smallest size of an ultrafine bubble depends upon the minimum number of molecules that can contain gas. [Figure A.1](#) shows, with the straight line, the size range of nano-objects (including bubbles) specified in ISO/TS 80004-1. This indicates that their diameters are 100 nm or less.

Recent developments of measurement technology of nano scale have proven that there are very small invisible bubbles of some sizes, which are stationary in liquid for a long time. Such bubbles, which are the major subject of discussion in ISO/TC 281, range approximately from 100 nm to 200 nm in diameter, measured in water.

Although nano-objects are specified as 100 nm or less in ISO/TS 80004-1, there is no scientific or convincing evidence for the time being that there is a difference in physical phenomena of ultrafine bubbles with the dividing line of 100 nm.

Therefore, ISO/TC 281 does not use the term “nanobubble” throughout the fine bubble documents it develops, and instead uses “fine bubble” or “ultrafine bubble” in order to avoid confusion in the industry, the market, and in international standardization activities.

In ISO/TC 281 documents, the term “nanobubble” appears only in this particular annex as an exception for the purpose of explaining why ISO/TC 281 does not use this term.

**Key**

- 1 fine bubbles
- 2 ultrafine bubbles
- 3 nano-objects
- a As specified by ISO/TC 281.
- b Nanobubbles have sizes within the size range of ultrafine bubbles.
- c Specified in ISO/TS 80004-1.

Figure A.1 — Size range of nano-objects of ultrafine bubbles and fine bubbles