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

Part 5:
Shelled bubble vocabulary

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Contents

Page

Foreword

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

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Introduction

Fine bubbles are the bubbles of a size typically less than 100 μm. Fine bubbles without a shell have recently seen growth in their applications in both industrial and biomedical fields, especially wastewater treatment, food processing, ultrasound imaging and medicine.

This document recognizes general principles of the definition of fine bubbles. However, it is to define the fine bubbles with shell materials encapsulation at the gas-liquid interface, resulting longer stability and controllability when application.

The shelled gas bubbles have shown extraordinary potential when used in the biomedical and food industries, especially in the applications of drug delivery and ultrasonic imaging. Shelled bubbles combine the unique responsiveness of bubbles to ultrasound and the specific functionalization of shells.

Bubbles have a strong acoustic impedance, which allows them to reflect sound waves far more efficiently than the surrounding fluid and biological tissue. Therefore, the use of bubbles in ultrasound imaging can effectively enhance the reflection of ultrasound, so as to obtain a higher image resolution. Contrast-enhanced ultrasound can be used to observe blood perfusion in an organ, to measure the flow rate of blood in the heart or other organs, and for a number of other purposes.

Different types of materials can also be chosen to endow bubbles with different functions, such as specific targeting, and carriers for drugs, genes and other contrast agents for multimodal imaging. Besides, bioactive gases such as oxygen gas, nitric oxide, hydrogen can be stored in the shelled bubble. Bubbles coated with nutritional ingredients or drugs can help to improve the nutrition or act as a medicinal aid in food.

When a gaseous core is encapsulated with shell materials encapsulated at the gas-liquid interface, it will result in longer stability and increased controllability when applied. With the shell, the size distribution of fine bubbles can be further controlled. The bioactive gasses (e.g. oxygen, hydrogen, nitric oxide) and/or soluble gases (e.g. carbon dioxide, sulfur dioxide, hydrogen sulfide, ozone) bubbles can be obtained in the solution for a longer duration time. Other functions of fine bubbles can be also tuned for specific applications. There is no document for distinction between a shelled bubble and nanoparticle or a fine bubble without a shell.

This document specifies terms, definitions and categories of a shelled bubble. Shelled bubbles accelerate further applications in the biomedical field, and also initiate new applications in other fields, such as energy storage, the food industry, environmental technology, agriculture and separation technologies. Development of appropriate general principles for usage, measurement and vocabulary for shelled bubbles is therefore critical to business trade or product acceptance by hospitals and consumers.