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Evaluation of a hemispherical-shaped array sensor for photoacoustic tomography
光超音波トモグラフィ用半球型アレイセンサの評価

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1. Introduction

In order to obtain a three-dimensional image (3D) with high resolution by photoacoustic tomography, a ultrasonic sensor has three technical problems that we should get over as follows;

(1) To fabricate a hemispherical-shaped array sensor for detecting signals propagating in various directions from various shaped absorbers such as blood vessels,

(2) To arrange piezoelectric transducers as many as possible within a hemispherical shape for obtaining a 3D image with high resolution,

(3) To realize a broadband sensor to be able to receive wide ultrasonic waves from low frequency to high frequency, because of ultrasonic frequency changes according to size of observation object.

And so, ImPACT has conducted image quantative evaluation by the hemispherical-shaped array sensor they developed using the piezoelectric element.
Besides, as part of the outgoing inspection, they evaluated the performance of 1024ch at varience with the echo from the metal ball using the focusing probe of non-destructive inspection.

2. Development of hemispherical-shaped array sensor

Conventional piezoelectric transducers in a product made of ceramics with piezoelectrical effect are hard and it was difficult to mold them as a spherical shape. We developed a new fabrication technology that combines the mold method with the flexible sheet of piezoelectric transducers[1)], such as **Fig. 1** and realized a hemispherical shape sensor that has 1024 channels within a hemispherical shape with a diameter of 110mm, such as **Fig. 2**. The flexible sheet was made of 1-3 composite transducer and its center frequency is 3.34MHz with 85% bandwidth, such as **Fig. 3**. The hemispherical-shaped array sensor was installed in a photoacoustic imaging system and realized 3D real-time imaging[2)]. The

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Fig. 1 Flexible sheet of piezoelectric transducers

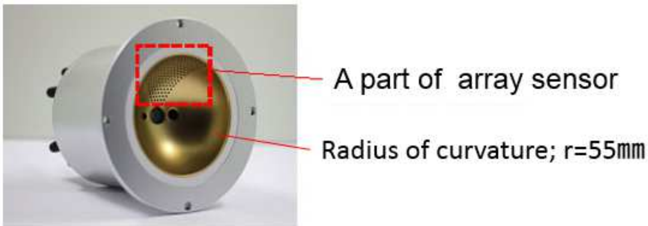

Fig.2 Hemispherical-shaped array sensor

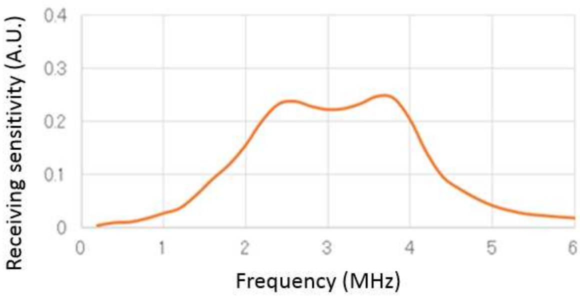

Fig.3 Frequency band of the composite transducer

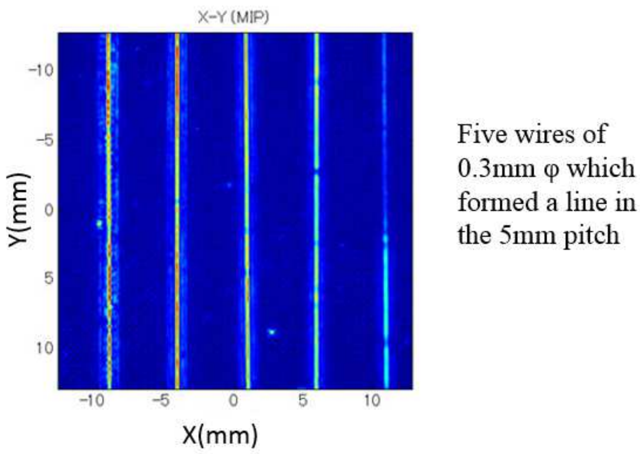

Fig.4 Image by photoacoustic imaging system

image is shown in **Fig.4** the wire at φ0.3 can be confirmed.

3. Evaluation of hemispherical-shaped array sensor

This sensor is connected by 128ch in each group for a total of eight coaxial cables, and the connector is located on for each of them. You can assess 128ch in a second by getting the echo from the stainless ball at φ10, using the multiplexer, such as **Fig.5**. You should place the ball target in the focusing location in the same way of non-destructive inspection method using the focusing probe and, then you should adjust A-mode or the location shown in **Fig. 7** by using the holder shown in **Fig.6**.

An example of measurement is shown in **Fig.8**. As the measurement result of 128ch, voltage peak of receiving for each of ch's echo was ; AVG=0.756(V)、MAX=0.966(V)、MIN=0.608(V)、STDEV = 0.097V. The performance value at varience from the average value is the maximum of +2.1dB, the minimum of -1.3dB, STDEV 13%, and 1.05dB. it's typically accepted at less than 4 dB in an array probe's insepection, and so, It'll be accepted it because the maximum value at varience is 3.5dB.

And, this value is for the transmit-receive sensitivity but the performance value at varience for receiving is assumed at 1.8 dB and we realized that it's uniform in the value because the receive-only's evaluated for the photoacoustic technique.

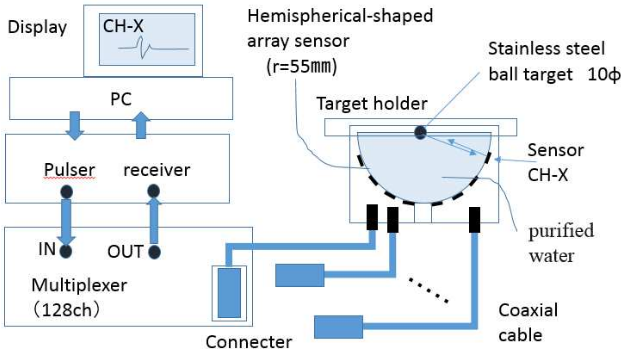

Fig.5 Block diagram of the evaluation equipment

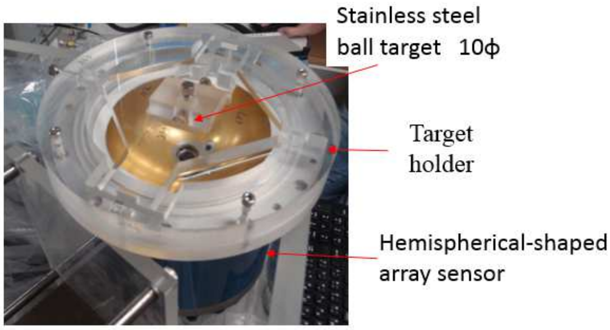

Fig.6 Set of the holder to hemispherical-shaped array sensor

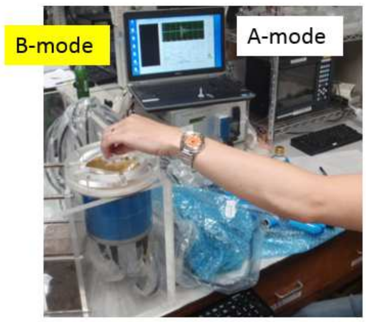

Fig.7 Central set of the ball target

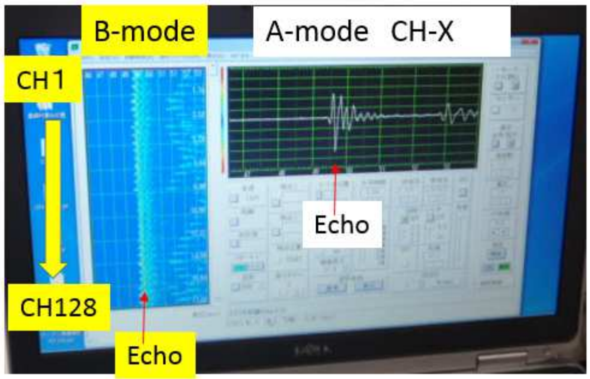

Fig.8 An example of the measurement screen

4. Summary

We can create 1024ch's hemispherical-shaped array sensor by using flexible piezoelectric element and, realized 3D real-time imaging.

And, we also could confirm that echo valuation method allows us to conduct the outgoing inspection without any laser equipment.

Acknowledgment

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References

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