

## Development and Application of Miniature High Sensitive Air Probe

小型・高感度エアプローブの開発とその応用

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### 1. Introduction

We have developed the miniature high sensitive air probe for non contact air coupled ultrasonic testing(NAUT) by one side access with the ultra high power square burst wave pulser and receiver, the pre-amplifier. This paper describes the information of bottom reflection in acrylic plate by V transmission method of NAUT.

### 2. One side surface V Transmission method

Fig.1 shows one side surface transmission method. Fig.2 shows NAUT21 and high speed scanner.

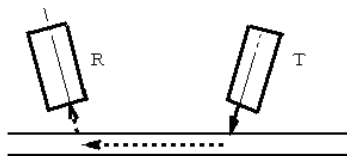


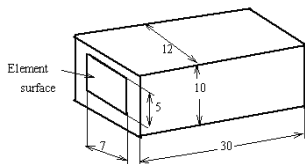
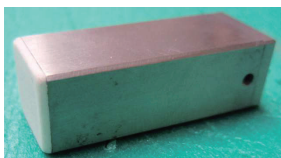
Fig.1 one side transmission method



Fig.2 NAUT21 and High Speed Scanner

### 3. Outline of Miniature Air Probe

Fig.3 shows outside appearance and dimension of miniature air probe. Its normal frequency is 800 kHz, the element size is 7mm vertical× 5mm wide in considering of angle incidence, the element is the composite material.

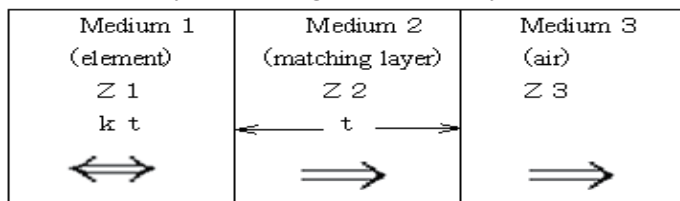


(a) Outside appearance (b) Shape and dimension  
Fig.3 Outside Appearance, shape and dimension

### 3.1 Probe Sensitivity

Miniature probe is generally less sensitivity than the normal probe, signal to noise ratio is

smaller, and becoming less sensitive, therefore even it is necessary to have good sensitivity. To have



good sensitivity, the following factor of element is necessary as shown in Fig.4.

- Fig.4 Construction of Miniature Air Probe
- (1) electric & mechanical coupling factor (Kt) and acoustic impedance ( $Z_1$ ) of element,
  - (2) thickness of acoustic matching layer ( $t$ ) and acoustic impedance ( $Z_2$ ) and
  - (3) combination of acoustic impedance of air ( $Z_3$ )
- We considered the above important factor for improving probe sensitivity and performance. especially the matching layer material and thickness.

### 3.2. Probe sound field and beam width

Fig.5 shows the beam width of the theoretical sound field in direction of 5mm element length by calculation in near field zone  $X_0=14mm$  of

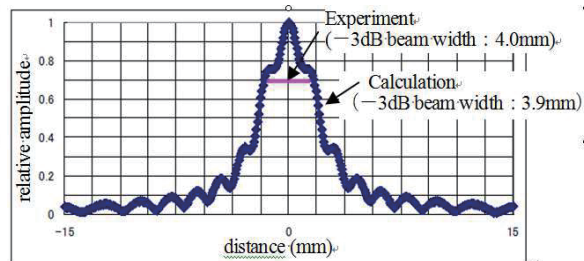
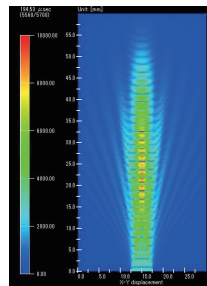


Fig.5 Comparison between calculated beam width and experiment (beam width

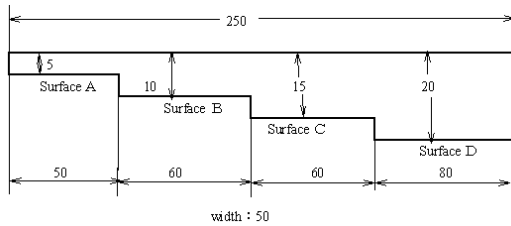
Rayleigh integral<sup>3</sup>). The calculation and measurement is good agreement. Fig6 shows the result of ultrasonic propagating simulator (SWAN21)<sup>4</sup>.



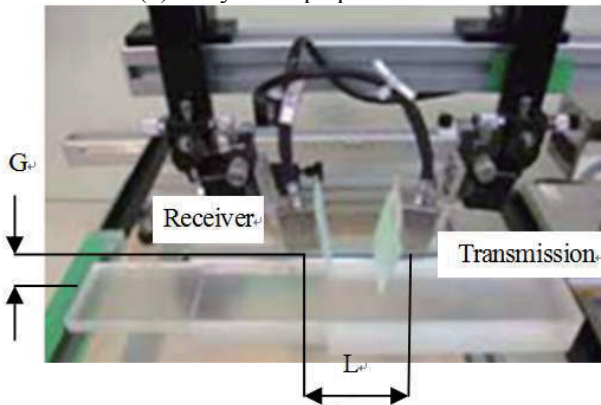
### 4. Image pattern picture by one side access V transmission method

Fig.6 result of ultrasonic propagating simulator

Fig.7 shows acrylic resin test specimen and experimental method to get the image pattern picture by one side access V transmission method in change of probe distance L & gap G.



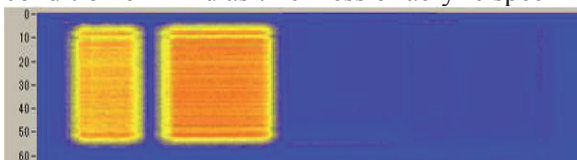
(a) Acrylic step specimen



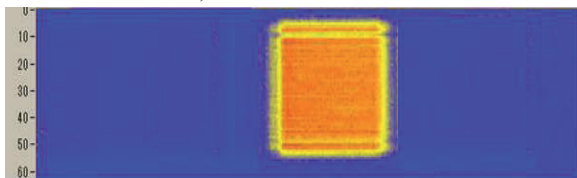
(b) Experimental method

Fig.7 Acrylic specimen and experimental method

The image pattern picture as shown in Fig.8 is very clear picture from surface A, surface B and surface C. The maximum amplitude value is obtained in the condition of  $L=2d$  as thickness of acrylic specimen



(Surface A) (Surface B) thickness  $d=5\text{mm}$  thickness  $d=10\text{mm}$   
(a) Probe distance  $L=20\text{mm}$



(Surface C) thickness  $d=15\text{mm}$   
(b) Probe distance  $L=30\text{mm}$



(Surface D)  $d=20\text{mm}$   
(c) Probe distance  $L=40\text{mm}$

Fig.8 Example of image picture pattern by one side V transmission method

d, the probe distance L, Therefore to get the clear image pattern picture from bottom surface A, B and C is the condition  $L=2d$  as above mention

### 5. Conclusion

We have developed the one side access V transmission method of non contact air coupled ultrasonic method (NAUT) by developed miniature probe in considering of sensitivity, sound field and beam width. The following conclusion obtained

- (1) The miniature probe is enough sensitivity even it is small.
- (2) The experimental result of sound field and beam width is good agreement with the theoretical result.
- (3) The clear image pattern picture from the bottom of acrylic resin specimen is obtained by one side access V transmission method.

### Reference

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