

The relation of real vibration frequency and nominal resonance frequency of the transducer

探触子の公称周波数とその振動子の共振周波数に対する実際の音の周波数との関係

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1 INTORODUCTION Transducer for nondestructive testing

The wave mode and the nominal frequency of the commercial nondestructive transducer are written in the date sheet. The measuring method and condition of resonance frequency, are not indicated clearly.

They use the center frequency of observed echo signal form the receiver. The echo is came from a specific reflector in the medium. The sound is generated by square pulser or spike pulser.

Usually transducer makers buy piezoelectric vibrator from piezoelectric ceramic maker. The frequency is specified as the ant resonance frequency.

On the other hand, the frequency of the piezoelectric vibrator transmitted wave is close to the resonance frequency. This frequency is so called characteristic frequency.

Also the wave velocity on the data sheet is calculated by the ant resonance frequency. Therefor the wave velocity and acoustic impedance

of the piezoelectric ceramic are not same as actual.

At the beginning, we checked the resonance frequencies by impedance analyzer (Agilent tech./KEYSIGHT).) as Fig.1.

2 The measured transmitting sound frequency (character frequency) and sound velocity

We test several piezoelectric materials. We show three material in Table1. F100 is piezoelectric material based on lead niobate for wider band transducer. The Q is closet to 20. C9 is PZT which dielectric constant is very high. M6 is anisotropy material based on lead titanate and used for good S/N flaw detection.

Generally resonance frequency is measured with an impedance analyzer as Fig. 1. The frequency of lowest impedance is called resonance frequency (Fr). The frequency of higher impedance is called anti-resonance frequency (Fa).

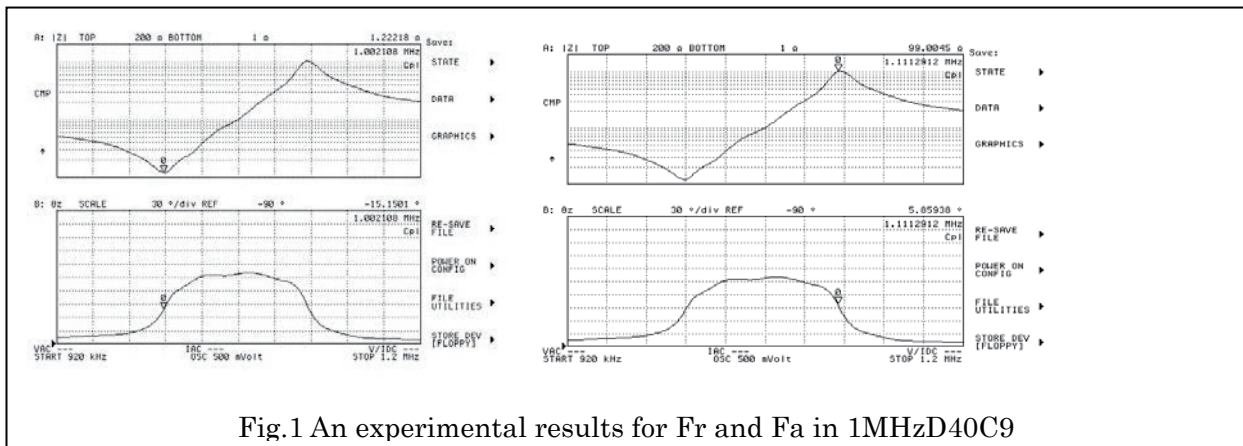


Fig.1 An experimental results for Fr and Fa in 1MHzD40C9

We measured Fa and Fr by two impedance analyzers. Both result are same.

We measured velocity with the transducer for precision thickness gage as Fig.2. The frequency is 20MHz. We use two methods; Peek to Peek method and Zero cross method.

As the result both are within 1% accuracy. We shows average of both in Tabel.1.

Almost piezoelectric ceramic is used as electric frequency generator. In this usage, lower impedance point is used. So piezoelectric vibrator is specified resonance frequency. The impedance analyzer is use (continues) forced exciting to measure impedance of electric parts same exciting method as electric frequency generators.

In pulse echo method, the pulse exciting is usually used. Very short pulse exciting pulse is used to generate sound wave. Therefore generated sound wave frequency is so called free resonance or characteristic frequency. The

characteristic frequency will close to experiences of transducer manufactures

We measured these characteristic frequency by spike pulser. The pulser excited the vibrates only 50nS. After this moment, output impedance of pulser goes up to 10M ohm. We measure the duration of potential on electrode of vibrators as Fig.3.

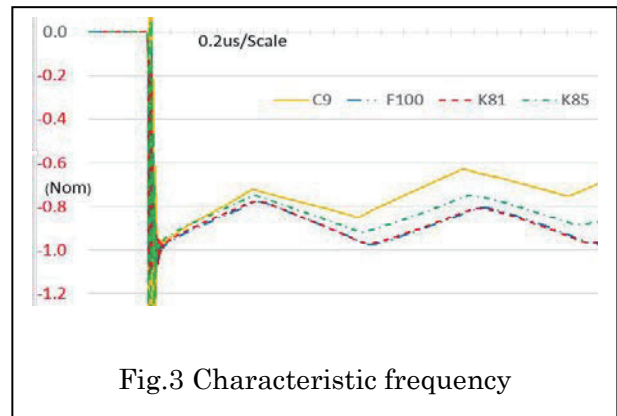


Fig.3 Characteristic frequency

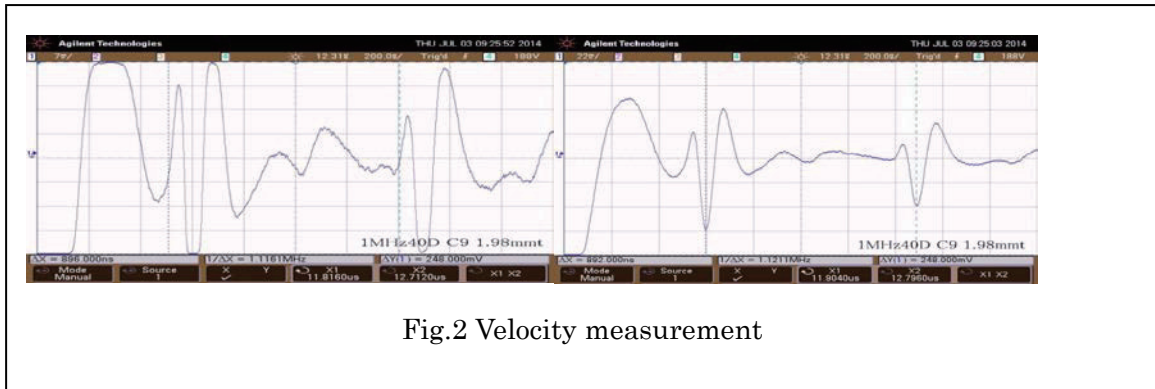


Fig.2 Velocity measurement

Table 1 Experimental results

Probe	Nominal Freq.	Actual Fr	Actual Fa	Actual Fo	Catalog Vel.	Actual Vel.	Desity
F100	500 kHz	491kHz	517.5 kHz	523 kHz	3260 m/s	3361m/s	5.7
C9	500	497	549	556	3900	4460	7.75
M6	1000	992	1130	1135	4460	4954	6.92

3 Conclusion

The differenc of nominal frequency and characteristic frequency is somewhere in 5% and 15%. This is almost same difference between resonance frequency(Fr) and anti resonance frequency(Fa).

The sound velocity shown on the piezoelectric material maker brochure is lower than actual velocity by Fr/Fa.