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Auto-measurement of resonant photoacoustic detection and its frequency characteristics

共鳴型光音響法の計測自動化と周波数特性

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1. Introduction

The attempt to apply acoustic resonance (such as pipe or Helmholtz resonator) to photoacoustic(PA) spectroscopy has been dominantly demonstrated in the application to the high-sensitive atomic or molecular detection rather than PA imaging[1]. At the previous USE conference, our group has analyzed and demonstrated open-resonator PA detection and imaging with a spheroidal acoustic resonator[2].

With the presence of the leakage, a leaky admittance will be parallelly added to the acoustic equivalence circuit so that the precise analysis requires both amplitude and phase signals at indivisual modulation frequencies.

In the view point described above, we developped an auto-measurement resonant PA system that can measure both amplitude and phasesignals with a software LabVIEW. In this paper, the system and the results will be presented.

2. Experimental apparatus

The basic experimental setup was shown in Fig. 1. A spheroidal acoustic resonator and other measurement hardware were the same as those presented at the last conference. The only difference is to adopt a software LabVIEW(National Instruments) to use a function generator (NF, DF1906) and a lock-in amplifier (NF, LI-5640). Furthrmore, a slide-stage was used to vary the distance between the specimen and a focus of the resonator.

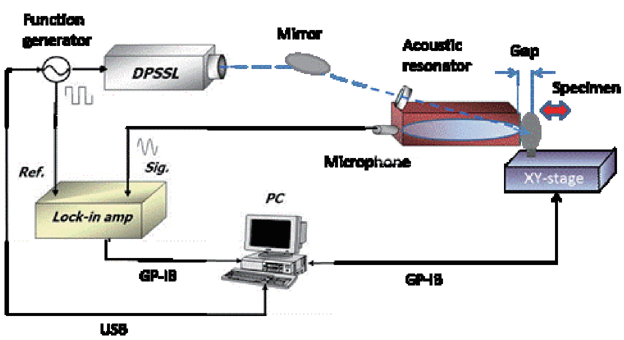

Fig. 1　The basic experimental setup

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3. Experimental results

Due to the improvement of the measuring system, PA amplitude and phase signals were obtained automatically and easily by the use of LabVIEW. The example of the obtained PA amplitude and phase signals were shown in Figs. 2 (a) and (b), respectively.

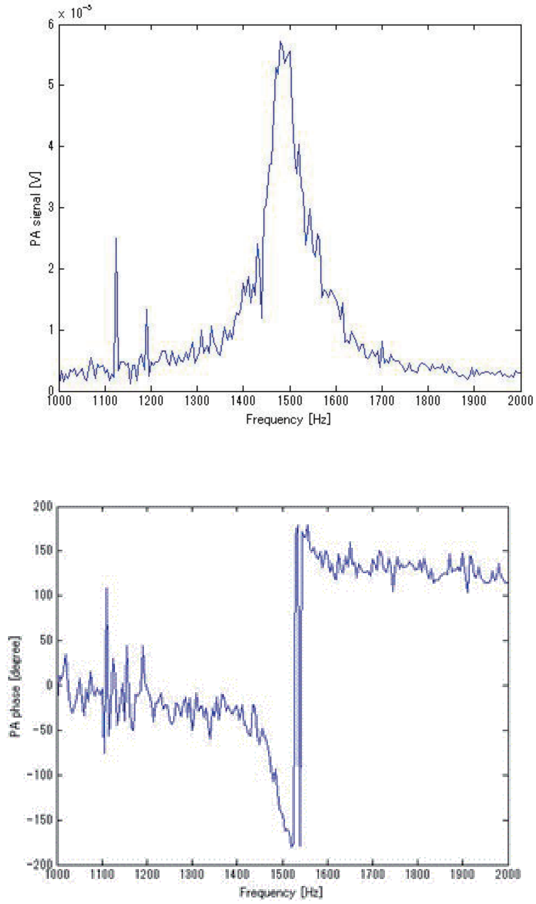

Fig. 2 Resonant characteristics of the (a) PA amplitude (upper) and (b) phase (lower) signals.

The resonant frequency of the acoustic resonance without leakage was agreed well with the designed value. With the presence of the leakage, PA signal was decreased at the small leakage, however with increasing the separation distance between specimen and the focus PA signal gradually increases. On the other hand, resonance frequency sifted toward higher frequency side monotonically. The characteristics were shown in Fig. 3

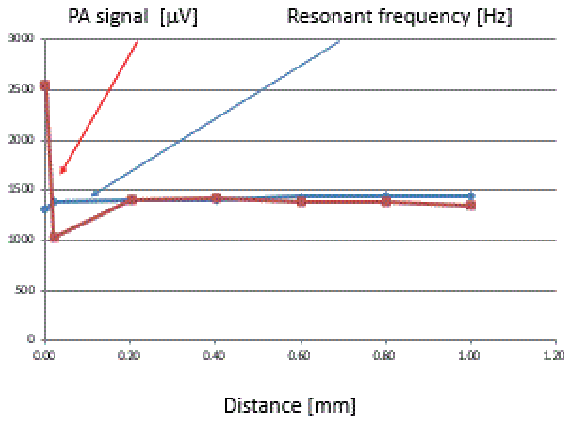

Fig. 3 Pa signal and resonant frequency dependence on the distance between specimen and the acoustic focal plane.

4. Discussions and conclusion

By improvement of the PA measuring system, PA amplitude and phase signals were easily measured and can be plotted like a Bode-plot. The frequency behavior of the complex PA signal can also be plotted in a complex-number plane in order to analyze a leaky component of the acoustic admittance. The present method is expected to contribute to the resonant-PA analysis including applications of PA imaging to the nondestructive inspection.

Acknowledgment

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