LEMBAR
HASIL PENILAIAN SEJAWAT SEBIDANG ATAU *PEER REVIEW*
KARYA ILMIAH : PROSIDING

Judul Artikel	: Development of Artificial Cochlea Using Microfabrication Method Based on P(VDF-TrFE)
Nama Penulis	: **Harto Tanujaya**, H.Shintaku, T.Kanbe, Y.Nakamoto, S.Kawano, T.Nakagawa and J.Ito
Jumlah Penulis	: 7 (tujuh)
Status Pengusul	: Penulis Pertama
Identitas Prosiding	: a. Judul Prosiding : The Sixth International Conference on Flow Dynamics b. ISBN/ISSN : - c. Thn Terbit, Tempat : Sendai, 4 - 6 November 2009 d. Alamat Repository PT/Web Prosiding : https://lintar.untar.ac.id/dokportofolio/forumilmiah/585ef3fd2102925abef5fee93a0f239e.pdf e. Terindex di : -

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Kelengkapan unsur & kualitas penerbit (30%)	88% x 30% x 15			3,96
Nilai *peer* Maksimal (100%)	15			13,53
Kontribusi Pengusul; (nilai akhir *peer* x bobot penulis pertama = **13,53 x 60% = 8,118**				**8,118**

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Jakarta, 18-12- 2019
Penilai I

(Prof. Dr. Ir. Agustinus Purna Irawan)
NIDN/NIP : 0328087102 / 10398021
Jabatan/Pangkat/Bidang Ilmu: Professor/IVC/Teknik Mesin
Unit Kerja: Fakultas Teknik – Universitas Tarumanagara

KOMENTAR *PEER REVIEW*	1. Tentang kelengkapan dan kesesuaian unsur: Artikel dengan judul **Development of Artificial Cochlea Using Microfabrication Method Based on P(VDF-TrFE)**, ditulis secara benar sesuai dengan standar penulisan artikel ilmiah yang memuat pendahuluan, metode/peralatan yang digunakan, pengambilan data dan data, analisa dan kesimpulan. 2. Tentang ruang lingkup dan kedalaman pembahasan: Artikel tersebut membahas mengenai pengembangan artificial cochlea dg material P(VDF-TrFE), dibahas secara spesifik dan mudah dipahami. 3. Kecukupan dan kemutakhiran data/informasi dan metodologi; Metodologi terstruktur dan jelas, data dan referensi yang diambil up to date. 4. Kelengkapan unsur dan kualitas penerbit: Kepanitiaan, reviewer makalah dan penyelenggara seminar jelas dan terdokumentasi. Artikel didalam prosiding dan dapat dibaca melalui daring. 5. Indikasi Plagiasi: Artikel dengan judul **Development of Artificial Cochlea Using Microfabrication Method Based on P(VDF-TrFE)** yang dipresentasikan di **The Sixth International Conference on Flow Dynamics** pada tanggal 4 - 6 November 2009 di Sendai, Japan dan diselenggarakan oleh Tohoku University, Japan, dapat dibaca secara daring https://lintar.untar.ac.id/dokportofolio/forumilmiah/585ef3fd2102925abef5fee93a0f239e.pdf tidak ditemukan indikasi plagiasi dengan tingkat kesamaan menggunakan software **Turnitin sebesar 11 %.** 6. Kesesuaian Bidang Ilmu: Artikel tersebut membahas tentang pengembangan artificial cochlea dg material P(VDF-TrFE) dan ada Linieritas keilmuan dengan pengusul.

Jakarta, 18.12. 2019
Penilai I

(Prof. Dr. Ir. Agustinus Purna Irawan)
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- [√] *Prosiding* Internasional
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Hasil Penilaian *Peer Review*

Komponen Yang Dinilai	Nilai Maksimal *Prosiding* Ilmiah (isi di kolom yang sesuai)			Nilai Akhir Yang Diperoleh
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Kelengkapan unsur & kualitas penerbit (30%)	4.5			4,275
Total = 100%	15			14,16
Kontribusi Pengusul; (nilai akhir *peer* x penulis pertama = 14,16 x 60% = 8,496				8,496

Komentar/Usulan *Peer Review:*	1. Tentang kelengkapan dan kesesuaian unsur: 2. Tentang ruang lingkup dan kedalaman pembahasan; 3. Kecukupan dan kemutakhiran data/informasi dan metodologi; 4. Kelengkapan unsur dan kualitas penerbit: 5. Indikasi Plagiasi: 6. Kesesuaian Bidang Ilmu: *Terlampir*

Jakarta, 14-11-2019
Penilai II

(Dr. Ir. M. Sobron Yamin L., M.Sc.)
NIDN/NIP : 0114056705 / 10311009
Jabatan/Pangkat/Bidang Ilmu: Lektor Kepala/IV/Teknik Mesin
Unit Kerja: Fakultas Teknik – Universitas Tarumanagara

KOMENTAR *PEER REVIEW*	1. Tentang kelengkapan dan kesesuaian unsur: Artikel **Development of Artificial Cochlea Using Microfabrication Method Based on P(VDF-TrFE)**, sesuai dengan kaidah penulisan artikel ilmiah yang meliputi pendahuluan, metode/alat, data dan analisa serta kesimpulan. 2. Tentang ruang lingkup dan kedalaman pembahasan: Ruang lingkup pembahasan artikel tersebut tentang manufaktur artificial cochlea dg material P(VDF-TrFE), dengan kedalaman pembahasan yang spesifik. 3. Kecukupan dan kemutakhiran data/informasi dan metodologi; Data yang diambil dan digunakan untuk analisa dan referensi tergolong baru dan mutakhir, dengan susunan metodologi yang baik. 4. Kelengkapan unsur dan kualitas penerbit: Penerbit dan penyelenggara seminar bergerak dalam dunia pendidikan dan sering mengadakan acara seminar/konferensi berskala nasional/internasional. Editor/ketua panitia dan reviewer untuk makalah tersusun jelas. Prosiding/artikel dapat dilihat secara online. 5. Indikasi Plagiasi: Artikel Development of Artificial Cochlea Using Microfabrication Method Based on P(VDF-TrFE) yang dipresentasikan pada tanggal 4 - 6 November 2009 di The Sixth International Conference on Flow Dynamics di Sendai, Japan dan diselenggarakan oleh Tohoku University, Japan, dapat dibaca secara daring https://lintar.untar.ac.id/dokportofolio/forumilmiah/585ef3fd2102925abef5fee93a0f239e.pdf dan tidak ditemukan indikasi plagiasi. 6. Kesesuaian Bidang Ilmu: Artikel Development of Artificial Cochlea Using Microfabrication Method Based on P(VDF-TrFE) dengan pembahasan tentang manufaktur artificial cochlea dg material P(VDF-TrFE) sesuai dan linier dengan bidang ilmu pengusul.

Jakarta, 14 - 11 - 2019
Penilai II

(Dr. Ir. M. Sobron Yamin L., M.Sc.)
NIDN/NIP : 0114056705 / 10311009
Jabatan/Pangkat/Bidang Ilmu: Lektor Kepala/IV/Teknik Mesin
Unit Kerja: Fakultas Teknik – Universitas Tarumanagara

Sixth International Conference on Flow Dynamics
November 4-6, 2009, Sendai, Miyagi, Japan

Development of Artificial Cochlea Using Microfabrication Method Based on P(VDF-TrFE)

Hario Tanuaya*, Hirofumi Shintaku*, Toshiya Kaebe*, Yohei Nakamoto*, Satoyuki Kawano*
Takayuki Nakagawa**, and Juichi Ito**
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ABSTRACT

The cochlea in the inner ear is an important organ for hearing. In this work, we develop a novel artificial cochlea using P(VDF-TrFE) to realize the fully implantable system for sensorineural hearing loss by microfabrication and film filters technologies. The device consists of a piezoelectric membrane made of P(VDF-TrFE) fabricated on a silicon substrate and discrete electrodes on the surface. The membrane converts mechanical deformation induced by acoustic waves to electric signals due to the piezoelectric effect. The geometry of the membrane is designed to realize the frequency selectivity at the range of 500 ~ 5,000 Hz. The experiment is carried out to investigate the vibrating characteristics of the membrane. To model the cochlear duct, the device is mounted on a substrate with a fluid channel filled with silicone oil. The results show that the resonant frequency is changed along the position due to the varying local mechanical boundary condition governed by the geometrical configuration. Furthermore, based on the relationship between position and the resonant frequency, it is found that the device can realize the frequency selectivity at the range of 1.45 ~ 10.65 kHz.

Keywords: Artificial Cochlea, Frequency selectivity, P (VDF-TrFE), Vibration, Fluid structure interaction

1. Introduction

Hearing is very important for human to communicate with others. In particular, children who have problem with their hearing get into trouble in their growth and the quality of life. In normal hearing, sound waves are converted into vibrations of basilar membrane (BM) in the inner ear. The hair cells on BM convert the sound wave into electric signals which are transferred to the brain via auditory nerve [1][2]. At present, there are several prostheses, i.e. cochlear implant, to help human who have hearing impairment that caused by malfunction of the hair cells in the cochlea. These cochlear implants consist of two parts; implantable stimulating electrodes (receiver and electrodes) and an extracorporeal device (batteries, processor and microphone). In our research we develop a fully implantable and self contained artificial cochlea using the piezoelectric membrane made of P(VDF-TrFE). The basic vibrating characteristics of the membrane are analyzed by applying sinusoidal acoustic waves to the device.

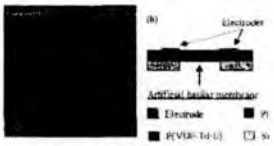

Fig. 1 Schematic of artificial cochlea (a) three dimensional view and (b) cross sectional view

frequency of acoustic wave range from 500 to 5,000 Hz by the device, the width of the membrane is linearly changed from 0.4 to 1.2 mm along x, whereas the length is designed to be 30 mm. The artificial cochlea is fabricated based on MEMS (Microelectromechanical Systems) and thin film technologies. The fabrication is started from the deposition of Pt film with the thickness of 460 nm on Si substrate. The piezoelectric material of

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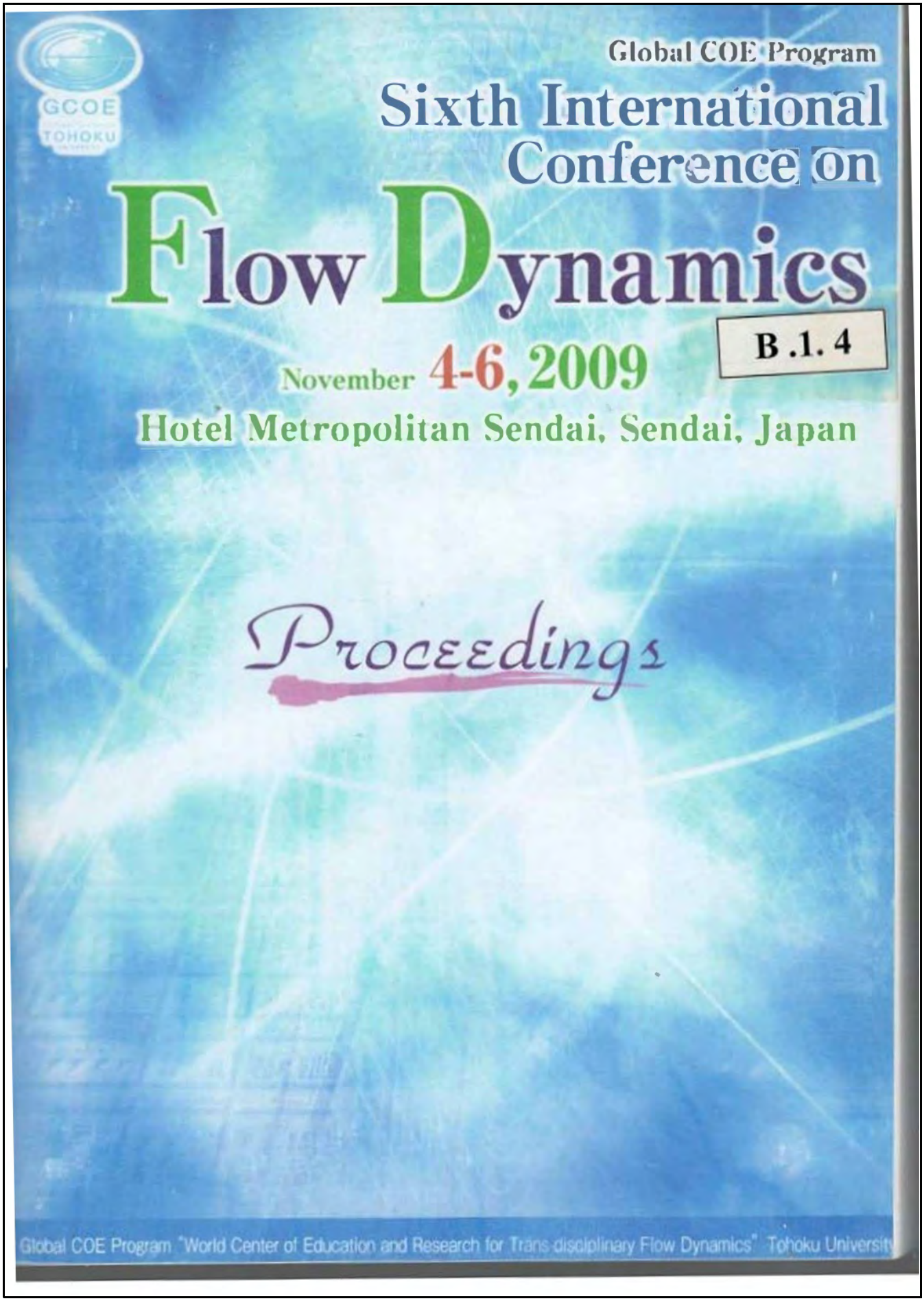
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56	9-32	**Development of Artificial Cochlea Using Microfabrication Method Based on P(VDF-TrFE)** Harto Tanujaya, Hirofumi Shintaku, Toshiya Kanbe, Yohei Nakamoto, Satoyuki Kawano, Takayuki Nakagawa and Juichi Ito (Hokkaido University, Japan)	270
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	9-37	**Prediction of UV/ VUV Irradiation Damage of Interlayer Dielectrics in Plasma Etching Using On-wafer Monitoring Technique** Butsurin Jinnai, Seiichi Fukuda, Hiroto Ohtake, and Seiji Samukawa (Tohoku University, Japan)	280
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	9-39	**Novel Prediction Method for Emission Efficiency of Eu^{2+}-doped Phosphors Based on Quantum Chemistry** Hiroaki Onuma, Itaru Yamashita, Kazumi Serizawa, Ai Suzuki, Hideyuki Tsuboi, Nozomu Hatakeyama, Akira Endou, Hiromitsu Takaba, Momoji Kubo, Akira Miyamoto (Tohoku University, Japan)	284

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Takayuki Nakagawa**, and Juichi Ito**
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2. Method

Figure 1 shows the artificial cochlea developed in this work. The artificial cochlea consists of a trapezoidal and piezoelectric membrane and 24 discrete electrodes on it. The membrane, which is named as an artificial basilar membrane, is vibrated by applying acoustic wave. The vibration is converted into the electric signal due to the piezoelectric effect. Because the width of the membrane is varied along the longitudinal direction, the local resonant frequency of the membrane changes as the position. As the result, a certain electrode has a specific frequency, where it gives the relatively large electric signal. Thus, the frequency of the acoustic wave can be detected based on the position of the resonance and the magnitude of the electric signals. To detect the

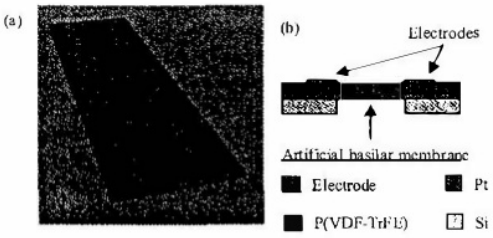

Fig. 1 Schematic of artificial cochlea (a) three dimensional view and (b) cross sectional view

frequency of acoustic wave range from 500 to 5,000 Hz by the device, the width of the membrane is linearly changed from 0.4 to 1.2 mm along x, whereas the length is designed to be 30 mm. The artificial cochlea is fabricated based on MEMS (Microelectromechanical Systems) and thin film technologies. The fabrication is started from the deposition of Pt film with the thickness of 460 nm on Si substrate. The piezoelectric material of P(VDF-TrFE) is formed on the Pt electrode with the thickness of 3.5 μm. The discrete electrodes are fabricated on the surface. To make the membrane flexible, the Si substrate is etched from the backside using Deep-RIE (Reactive Ion Etching).

The vibrating characteristics of the membrane are measured with mounting the device on a substrate with a fluid channel. The fluid channel is a model of cochlea duct and is filled with silicone oil of a model of lymph liquid. The sinusoidal acoustic wave at 75 dBSPL is applied to the artificial cochlea. Distance between speaker and artificial cochlea is 150 mm with tilt angle of 60 deg. The frequency is controlled from f = 1.0 to 15 kHz, where the range is in the human hearing. The vibrating amplitude is measured using Laser Doppler Vibrometer (LDV).

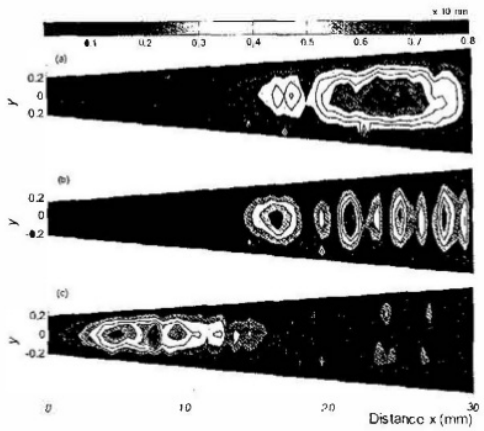

Fig. 2 Contour maps of the vibrating amplitude of artificial basilar membrane at f = (a) 1.45, (b) 3.95, (c) 10.6 kHz.

3. Results and discussion

Figure 2 shows the amplitude distribution at (a) 1.45, (b) 3.95 and (c) 10.6 kHz, respectively. The results show different vibrating behavior at each frequency. The amplitude increases at a certain local place, where the resonance is occurring. The places of the maximum amplitude at each frequency are different. The position x with the maximum amplitudes decreases as the frequency increases. Note that the local maximum amplitudes are considered as the results of the standing waves in x direction.

Figure 3 shows the frequency dependence of the vibrating amplitude at x = (a) 28.5, (b) 13.9 and (c) 5.8 mm, respectively. The amplitudes at different places show clear peaks at different frequencies. The frequency at the peak is considered as the resonant frequency at the local area of the membrane. The value seems higher at smaller x, i.e. the narrower area. This is corresponding to the results in Fig. 2. This feature is owing to the local mechanical boundary condition which is determined by the shape of the membrane. That is, the wavelength of the acoustic wave is affected by the width of the membrane.

Figure 4 shows the resonant frequency at various position x. The resonant frequency is ranged from 1.45 to 10.65 kHz and decrease as x. Compared with the theoretically predicted values of the frequency of 0.5~5 kHz, the measured ones are higher. The further discussion on the underestimation in the frequency should be carried out by increasing the number of the experiments.

4. Concluding remarks

Frequency selectivity of the artificial basilar membrane is confirmed at the range of 1.45 ~ 10.65 kHz. The resonant frequency increases as the width of the membrane decreases. The theoretically predicted value of the frequency is lower than the experimental measurement.

Acknowledgement

The author would like to acknowledge the support of Ministry of National Education Republic of Indonesia and gCOE Osaka University. Special thanks are due to Dr. Yoichi Kagaya for his help in this research.

References

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[2] Wever, E.G., Lawrence, M., Phys. Acoustic Princeton Univ. Press, NJ, (1954).

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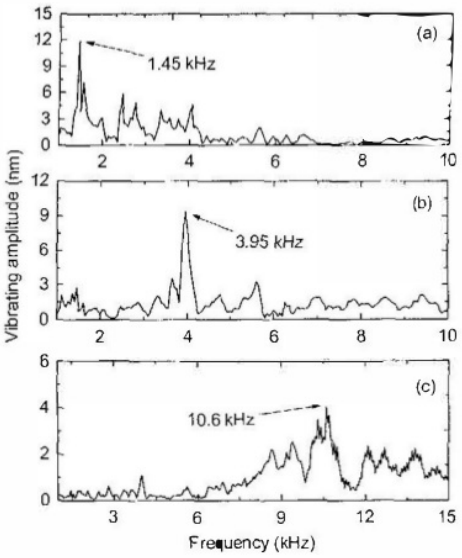

Fig. 3 Frequency dependence of vibrating amplitude of the artificial basilar membrane at x = (a)28.5, (b)13.9, (c)5.8 mm.

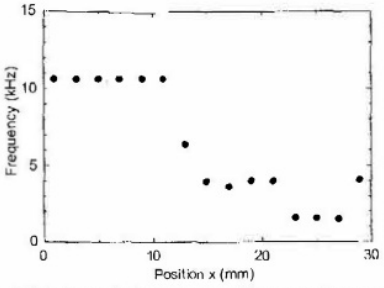

Fig.4 Relationship between position x and resonant frequency.