E-NEWSLETTER

December 2018 issue

THE SOCIETY OF ACOUSTICS SINGAPORE

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Registration No: 0331/1989
Year of Registration: 1989

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Secretary: Prof Y F Zhou
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CONTENTS

I.CONFERENCE NEWS

The 26th International Congress on Sound and Vibration(ICSV26) will be held in Montreal, Canada from 7 to 11 July 2019.

Woon Siong Gan will be organising three structured sessions on:

1. **Nonlinear acoustics and vibration**
2. **Acoustic metamaterials & phononic crystals: fundamentals and applications**
3. **Sound propagation in curvilinear spacetime**

Please visit www.icsv26.org for more informations.

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II.ANNONCEMENTS

The Society of Acoustics will be sending out invoices to members with outstanding membership subscriptions. Members are encouraged to make payment in support of the Society.

The E-Newsletters will be made available to industrial contacts in an effort to promote the activities of the Society.

The Society is also exploring the possibility of organising talks and other professional events in collaboration with acoustic societies of other countries.

Membership Certificates will soon be made available to all members who had made full payments of membership dues

The Society aims to increase membership by inviting all persons, including those from the institution of higher learning and other related societies such as the Institute of Architects, Singapore and the members of the mechanical engineering division of the Institution of Engineers, Singapore who are qualified in the various field of Acoustics to join our Society.

We are especially keen to invite students to join our society and we are establishing the Youth Chapter soon.

III.INTERNATIONAL ACOUSTICS NEWS

Woon Siong Gan was recently elected as a Director of the International Institute of Acoustics and Vibration(IIAV) for the period 2018 to 2022.

IV.MEMBERSHIP SUBSCRIPTION

Fellow	S$70
Member	S$50
Associate	S$30
Student	S$15
Corporate	S$200

FEE BASED ON ANNUAL RATE

FOR MORE INFORMATION PLEASE CONTACT: Dr. Woon Siong Gan at email: wsgan5@gmail.com

Membership application forms can be downloaded from the society website: www.acousticssingapore.com. Please complete and email to wsgan5@gmail.com

V.ARTICLES

The 50th Anniversary of the Transport Theory in Condensed Matter Physics

Woon Siong Gan

This year will be celebrating the 50th Anniversary of the transport theory in condensed matter physics. Woon Siong Gan coined and invented the name transport theory during his PhD works at the physics department of the Imperial College London in 1966. . His PhD thesis[1] Transport Theory in Magnetoacoustics is dated 1969. In the past transport theory has been used only in neutron transport theory for the design of nuclear reactors. His PhD thesis first introduced transport theory into condensed matter physics. Transport theory is a manifestation of the Boltzmann transport equation which is used in classical statistical mechanics. This is an integral equation in terms of the Boltzmann probability distribution function. Transport theory also introduced the role of phase transition into condensed matter physics. It is the theory of transport phenomena. Electrons and phonons are transport phenomena.

There is a singularity behaviour of the transport properties during the phase transition. It is of interest to note that in the year 1967, Philip Anderson and Volker Heine changed the name of the solid state theory group at the Cavendish Laboratory, Cambridge University to condensed matter theory group to reflect the important role of phase transition and this is also the unification of solid state physics and liquid state physics to form condensed matter physics. Hence his PhD thesis also played a role in the founding of the field of condensed mater physics. Today transport theory is the key foundation of the theoretical design of new materials. Its status in condensed matter physics is equivalent to that of the Yang Mills theory in particle physics.

As a start transport theory is a classical theory. However, as time evolved , it has been developed into the quantum transport theory since the 1980s. Quantum transport theory has given rise to the award of three Nobel physics prizes: the Quantum Hall Effect, the Anderson Localization, and the Onsager Reciprocal Relations. Today quantum transport theory plays a more important role than classical transport theory in condensed matter physics.

What is transport theory?

Transport theory is the theory of transport phenomena. Examples of transport phenomena are electrons and phonons (J.M. Ziman, Electrons and Phonons, The Theory of Transport Phenomena in Solids, Oxford University Press, 2001)[2]and ultrasound attenuation in solids.Transport phenomena have wide applications in in condensed matter physics, the motion and interaction of electrons, holes, and phonons are studied under transport phenomena. In biomedical engineering, some transport phenomena of interest include microfluidics,thermoregulation, and perfusion. In mechanical engineering, transport phenomena are studied in reactor design, analysis of molecular or diffusive transport mechanisms and metallurgy.

In materials, atoms are arranged in a particular way. A stimulus takes material away from thermal equilibrium. Then material responds by transferring energy, charge, spin,momentum etc from one spatial part to another. Transport theory is an attempt to construct a theory that related material response to the stimulus. All materials are used for their response to stimulus, e.g. wool(sweater).silicon(computer chip), copper(wire), carbon (writing) etc. Key material question: what atoms and how should I arrange them to get a desired response to a particular type of stimulus. Hence transport theory lays key foundation of theoretical materials design.

Onsager Reciprocal Relations

Onsager reciprocal relations is an example of transport phenomena. Onsager reciprocal relations express the equality of certain ratios between flows and forces in thermodynamic systems out of equilibrium, but where a notion of local equilibrium exists. Reciprocal relations occur between different pairs of forces and flows in a variety of physical systems. For example, consider fluid systems described in terms of temperature,matter density, and pressure. In this class of systems, it is known that temperature differences lead to heat flows from the warmer to the colder parts of the system. Similarly, pressure difference will lead to matter flow from high pressure to low pressure regions. What is remarkable is the observation that when both pressure and temperature vary ,temperature differences at constant pressure can cause matter flow(as in convection) and pressure differences at constant temperature can cause heat flow. Perhaps surprisingly, the heat flow per unit of pressure difference and density(matter) flow per unit of temperature difference are equal. This equality was shown to be necessary by Lars Onsager using statistical mechanics as a consequence of the time reversibility of microscopic dynamics(microscopic reversibility). The theory developed by Onsager is much general than this example and capable of treating more than two thermodynamic forces at once with the limitation that the principle of dynamical reversibility does not apply when (external) magnetic fields or Coriolis forces are present, in which case the reciprocal relations break down.

The Quantum Hall Effect

The quantum Hall effect is a quantum mechanical version of the Hall effect, observed in two-dimensional electon systems subjected to low temperatures and strong magnetic fields, ih which the Hall conductance undergoes quantum Hall transitions to take on the quantized values

$$\sigma = \frac{I_{channel}}{V_{Hall}} = \nu\frac{e^2}{h}$$

where $I_{channel}$ = channel current, V_{Hall} = Hall voltage, e = elementary charge, and h = Planck's constant. The prefactor ν is known as the filling factor and can take on either integer or fractional values.

The quantum Hall effect is referred to as the integer or fractional quantum Hall effect depending on whether ν is an ineger or fraction respectively. The striking feature of the integer quantum Hall effect is the persistence of the quantization(i.e. the Hall plateau) as the electron density is varied. Since the electron density remains constant when the Fermi level is in a clean spectral gap, this situation corresponds to one where the Fermi level is an energy with a finite density of states, though these states are localized The fractional quantum Hall effect is more complicated as its existence relies fundamentally on electron-electron interactions. The fractional quantum Hall effect is also understood as an integer Hall effect although not of electrons but of charge flux composites known as composite fermions. There is also a new concept of the quantum spin Hall effect which is an analogue of the quantum Hall effect where spin currents flow instead of charge currents.

Anderson Localization

In condensed matter physics, Anderson localization is the absence of diffusion of waves in a disordered medium. This phenomenon is named after the Americam physicist P W Anderson who was the first to suggest that electron localization is possible in a lattice potential,provided that the degree of randomness (disorder) in the lattice is sufficiently large, as can be realized for example in a semiconductor with impurities or defects. Anderson localization is a general wave phenomenon that applied to the transport of electromagnetic waves, acoustic waves, quantum waves, spin waves, etc. This phenomenon is to be distinguished from weak localization, which is the precursor effect of Anerson localization., and from Mott localization, named after Sir Nevill Mott where the transition from metallic to insulating behaviour is not due to disorder but to a strong mutual Coulomb repulsion of electrons. It is shown that strong disorder can be employed to obtain high quality wavefront due to the Anderson localization phenomenon in a transverse Anderson localizing optical fiber.

International Journal on Transport Theory

In 1971, the International Journal of Transport Theory and Statistical Physics was published by Taylor & Francis. It is still in existence today although the name has been changed to Journal of Computational & Theoretical Transport in 2014.

Books on transport theory:

1.Transport Theory by James J Duderstadt & William R Martin, John Wiley & Sons,1979.

This is on classical transport theory.

2.Quantum Transport Theory (Frontiers in Physics) by Jorgen Rammer, Westview Press, Sep 3,2004, 539 pages.

3.Theory of Quantum Transport at Nanoscale, An Introduction by Dmitry A Ryndyk, Springer International Publishing, 246 pages, 2016

This is on quantum transport theory

4.Quantum Transport by Supriyo Datta, Cambridge University Press, 2005

This is on quantum transport theory

5.Quantum Transport: Introduction to Nanoscience by Yuli Y Nazarov & Yaroslav M Blanter

This is on quantum transport theory

6.Quantum Transport in Nanoscale Devices by D Vasileska, D Mamaluy, I Knezevic, H R Khan, and S M Goodnick

This is on quantum transport theory

Transport theory used in Phase Transition and in Metamaterials Design

The following is an example on how the transport theory can play a role in the theoretical design of new materials. It is of interest to note that in a metamaterial there is a singularity behaviour of the transport properties at the point of phase transition or at the resonance frequency. The permittivity will rise to infinity with a sudden drop to negative infinity and then with a gradual rise in the negative region This is similar to the hyperbolic shape. Some examples of transport properties are conductivity, permeability, permittivity, viscosity, thermal conductivity, diffusivity etc. Hence by studying the singularity behaviour of different transport properties at the point of phase transition , one can discover new materials theoretically.

References

1. Woon Siong Gan, Transport Theory in Magnetoacoustics, PhD thesis, 1969, Imperial College London, unpublished.

2. J.M. Ziman, Electrons and Phonons, The Theory of Transport Phenomena in Solids, Oxford University Press, 2001

Introduction of Products from Sealed Air Singapore Pte Ltd with Compliance Certificate

<u>Sealed Air Releases Stratocell Whisper™ in Singapore</u>

Sealed Air is proud to offer a unique closed cell polyolefin foam sound absorption material in the Singapore market called Stratocell Whisper™. Two versions of the patented product are available, Whisper® FR for interiors, and Whisper® UV for outdoor use.

Characteristics that are unique to closed cell membrane absorption are at 50mm thick:

Very high absorption for mass with an NRC of 1

Sustained performance in the presence of high levels of moisture

High transmission loss - Rw 13dB at 50mm

Airflow resistance in excess of 2.7M rayls

Fibre free

With a mass of only 1.25kg/m2 Stratocell Whisper™ makes very efficient use of raw resin inputs, making it a sustainable choice. Uncontaminated product is also recyclable in LDPE recycling streams.

Stratocell Whisper™ is manufactured in Italy by Sealed Air: a leading manufacturer of low density polyethylene foam and specialty packaging. Whisper® has been successfully used on the German Deutsche Bahn, in rail and road applications, lining generator enclosures, plant rooms, marine engine compartments, and in air handling silencers and shooting ranges.

Stratocell Whisper features acoustic absorption that is unchanged by the presence of high levels of atmospheric humidity which means that there is no need to de-rate installations and no need to bag material or fit protective covers. One situation where this is important is around indoor pools where long reverberation times can be detrimental to learning outcomes, make instructions from lifeguards difficult to comprehend, and reduce the enjoyment of the facilities by its patrons.

Recently in NSW Australia, Rodney Stevens Acoustics tested Stratocell Whisper™ in an indoor pool complex at Wollondilly Community Leisure Centre. Fifteen measurements were made putting the RT(60) compliance in the range of 3-4 seconds within the 15,998m3 facility.

100 of the 1.2 x 2.4M Stratocell Whisper™ panels (288m2) were installed as vertical hanging baffles at strategic locations around the complex. The result was the RT(60) measured at the same 15 locations post installation was reduced to the range of 0.6-0.8 seconds, close to ideal levels for classroom acoustics. The hanging baffles were installed by two workers

using a scissor lift, and existing rigging wires in place within the complex. The total installation time was less than 1.5 days, and the complex did not close.

No 6 Penjuru Ln
Singapore 609187
Tel: (65) 6379 5000
Fax: (65) 6370 5979
www.SealedAir.com

A range of independent test reports are available for the acoustic parameters as hanging baffles, wall linings and as barriers in combination with common building materials.

Please contact Shermaine Wong for more information.

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Sales Manager, Product Care

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Sealed Air's unique noise control solution makes big splash at indoor swimming complex

February 2017

Community swimming pools have been an integral part of Australian life for nearly a century.

In the modern era indoor swimming facilities with heated pools now allow year round swimming for families across the nation.

They cater for hundreds of swimmers of all ages in the summer season – providing fun, fitness and health.

But these open plan expansive indoor facilities can also be a health hazard – creating deafening noise levels for swimmers, staff and patrons.

This was the case at the indoor swimming complex at the Wollondilly Community Leisure Centre in the picturesque town of Picton, southwest of Sydney.

Built by Wollondilly Shire Council in 2003, the facility boasts a 25m x 8-lane heated indoor pool.

Operated by Leisure Management Services, it allows year round swim classes, school swimming carnivals and aquatic programs – seven days a week.

Up to 500 people of all ages use the facility each day in summer and at times the noise was earsplitting.

“The existing material banners were old, stained and ineffective in reducing noise,” said David Emmett, Facilities Maintenance Coordinator at Wollondilly Shire Council.

“Visually they were a blight on the centre,” he said.

Wollondilly Leisure Centre manager James Barnes agrees.

“On most days it was hard to have a conversation,” Mr Barnes said.

“It was difficult for the swimming instructors to talk to the kids and parents couldn’t talk to each other – it was really unpleasant.”

The solution

To solve the problem the Council turned to Soundblock Solutions, a leading Australian provider of soundproofing products and solutions.

Soundblock had no hesitation in recommending Stratocell Whisper®, a revolutionary new sound absorbing foam developed and manufactured in Europe by SealedAir.

Stratocell Whisper® can reduce interior and exterior noise levels by up to 70 percent.

The polyethylene foam material is ideal for indoor and outdoor industrial, commercial and residential environments where reverberant noise is a problem.

The lightweight panels absorb sound energy, reduce echo and eliminate the problem of reverberation.

The acoustic sound absorbing panels not only control noise, they allow workers and patrons to speak and hear more effectively to provide a safer environment.

The product is washable, durable, long lasting and easy to install.

Earlier this year Soundblock Solutions installed 100 Stratocell Whisper® panels at strategic points in the pool area.

Why was Stratocell Whisper® chosen?

“There were other cheaper alternatives however, they were unable to supply any scientific proof that the product worked,” said Mr Emmett.

Soundblock Solutions was able to provide evidence of effectiveness for the product.

“Council is satisfied that there is a significant noise and reverberation reduction in the indoor pool area,” Mr Emmett said.

James Barnes said the new panels were installed in just two days – and there was no need to close the pool.

“The staff especially are happy with the outcome – it’s made a huge difference,” he said.

The Wollondilly Leisure Centre employs 65 staff members, including 25-30 swimming instructors.

An acoustic report prepared by Rodney Stevens Acoustics, a Sydney-based firm, found that speech intelligibility has drastically improved with the installation of the Stratocell Whisper® panels.

Acoustic engineer Rodney Stevens carried out reverberation testing at 15 locations in the pool complex

“Before installation we measured response times (RT) of 3 to 4 seconds,” Mr Stevens said.

“But after installing only 100 panels the results improved significantly to between 0.6 and 0.8 seconds.

“This is close to the recommended response times for classrooms of 0.4 to 0.6 seconds.”

Mr Stevens said the general acoustic atmosphere within the enclosed pool area is now at a level of human comfort.

“The pool complex has become an enjoyable recreational facility because of the acoustic environment,” his report concluded.

(See acoustics report attached)

Swim school manager Julie Coulter, a key member of the Leisure Centre staff for more than eight years, says the facility is much quieter since the new material was installed.

“We run up to 1600 swim classes every year for babies and pre-schoolers and the noise was terrible,” Ms Coulter said.

“Sometimes there are five classes happening right next to each other.

“The kids couldn’t hear the instructors properly and they (the instructors) were becoming quite hoarse because they had to talk so loud to be heard.

“With the old sound proofing material it was very noisy … and it was ugly.

“The new material is fantastic – it’s much quieter now – and the black and white looks great.”

Ms Coulter said there was a brief period at the pool when there was no soundproofing at all before the new panels were installed.

“It was mayhem – you couldn’t hear a thing,” she said.

“When the new panels were installed everyone breathed a sigh of relief – including the parents.

“We’re all happy now … it’s better for everyone.”

Mr Emmett said staff and patrons have commented on the noise reduction at the complex as well as the “cleaner, less obtrusive appearance of the baffles.”

Rachel Hollier, from Thirlmere near Picton has been visiting the pool for more than six years.

Her three children aged 2, 4 and 7 years are all learning to swim there.

“Previously it was very difficult to have a conversation,” she said. “The noise levels are now very comfortable.”

And Tracey Sanders from Picton has been bringing her son Matai to the pool for swimming lessons for the past two years.

“The noise levels are so much better since they installed the new panels,” Tracey said.

For more information about Stratocell Whisper® and how it can solve your noise problems visit:

www.sealedair.com or www.soundblock.com.au
Wollondilly Leisure
Centre www.wclc.com.au

Pic captions:

The new Stratocell Whisper® black and white sound absorbing panels at Wollondilly Community Leisure Centre indoor swimming complex, Picton

Wollondilly Leisure Centre manager James Barnes

Swim school manager Julie Coulter

Rachel Hollier with children Samuel and Hannah

Tracey Sanders with Matai (left) and Jacks

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23rd November 2016

Project Number 160995R1

COMPLIANCE CERTIFICATE

Wollondilly Community Leisure Centre - Internal Acoustics
434 Argyle Street
Picton NSW 2571

Rodney Stevens Acoustics (RSA) was requested by Soundblock Solutions to assess the Reverberation Times (RT60) within the Wollondilly Community Leisure Centre pool complex. Reverberation Time is usually stated as a decay time and is measured in seconds. Decay time is the time it takes the signal to diminish 60 dB below the original sound.

The purpose of the assessment was to accurately determine the required absorption coefficient to improve the Reverberation time of the pool area. Extensive RT testing carried out gave an average RT of between **3.0 and 4.0 seconds**.

The results clearly demonstrated that the internal acoustics Reverberation Time (RT 60) is extremely high and would cause difficulties with speech recognition and may potentially be a safety hazard (workcover) as a result of pool attendants giving instruction to occupants within the pool not being clearly understood.

SoundBlock Solutions have installed 100 absorption panels surrounding the pool. The panels are Stratocell Whisper. Stratocell Whisper is a closed cell polyethylene foam which has cells that are subsequently opened through the manufacturing process resulting in a highly effective sound absorption material. There are many unique features such as superior noise control, sound rating NRC 1.0, resilient to water and humidity, flame retardant, light weight, non-corrosive, easy to fix and fasten and self-standing and structurally independent.

Australian Standard 2107 – 2000 Acoustics – *Recommended design sound levels and reverberation times for building interiors* States under Indoor Sports Buildings “Reverberation time should be minimized as far as practicable for noise control”.

Calculating the reverberation time uses the Sabine equation:-

$$T_r = 0.161\frac{V}{A}$$

The reverberation time (Tr, in seconds) is directly proportional to the volume of the room (V, [m3]) and inversely proportional to the room's effective surface area (A, [m2]). The effective surface area is the sum of the product of an area covered by a particular material and the material's absorption coefficient.

$$A = \sum_{i=1}^{n} \alpha_i A_i = \alpha_1 A_1 + \alpha_2 A_2 + \alpha_3 A_3 + \dots$$

For a surface of area A and with absorption coefficient a, aA can be thought of as the equivalent area of a perfect absorber (open window). The absorption coefficient varies with frequency and so the reverberation time is a function of frequency.

The Australia/New Zealand standard AS/NZS 2107:2000 Acoustics – Recommended design sound levels and reverberation times for building interiors provides recommended design sound levels and reverberation times for building interiors. The untreated indoor pool area gave an average RT between **3.0 and 4.0 seconds**.

The recommended Reverberation times (RT60) for Schools is **0.4 to 0.6 seconds;** and for Speech Auditoriums, Lecture Theatres, Conference and Convention Centres, Drama Theatres **0.7 to 1.0 seconds.**

COMPLIANCE TESTING.

Soundblock Solutions has advised RSA that 100 recommended acoustic Whisper panels have been installed in the pool area. RSA was requested to carry out extensive reverberation testing to determine the current RT.

Reverberation testing was carried out on Tuesday 22nd November 2016 in the same 15 locations within the enclosed Wollondilly Community Leisure Centre pool. Extensive RT testing carried out gave an average RT of between **0.6 and 0.8 seconds.**

The Reverberation Times of the pool area within the Wollondilly Community Leisure Centre has drastically improved. The speech intelligibility has also drastically improved with the installation of the Whisper panels.

It is the professional opinion of Rodney Stevens Acoustics that the overall speech intelligibility and general acoustic atmosphere within the enclosed pool area is now at a level of human comfort. The pool complex has become an enjoyable recreational facility because of the acoustic environment.

Rodney Stevens - MAAS

Director

Rodney Stevens Acoustics Pty Ltd

VI.REPORT ON CONFERENCES

The Regional Conference on Acoustics and Vibration (RECAV) organised by the Society of Acoustics(Singapore)

and the Association of Acoustics and Vibration Indonesia(AAVI) was successfully held in Bali,Indonsia from 27 to 28 Nov 2017. There were 110 presentations from 14 countries with 60% of them from Indonesia. There were also some 18 exhibition booths. This reflected strong local participation and the international nature of the conference.

VII. BID FOR FUTURE INTERNATIONAL CONFERENCES

The Society of Acoustics(Singapore) will be hosting the ICSV28 in Singapore from 25-29 July 2021 at the Marina Bay Sands Hotel.

Government Bodies

www.mom.gov.sg

www.nea.gov.sg

www.lta.gov.sg

Technical and Research Sites

Corporate Sites

www.metaultrasound.com

www.noisecontrols.com

(The Society welcomes interested parties to contribute relevant websites to the above e useful links. For more information, please contact us. Thank you.)

Disclaimers

President: **Woon Siong Gan**
E-Newsletter compiled by: **Woon Siong Gan**