VACUUM Group newsletter 2020

IOP Institute of Physics
Vacuum Group

NEWSLETTER 2020

Issue 20/1

IOP Vacuum Group Newsletter 2020

Contents

1. The Vacuum Group

A Vacuum Physics Group of the IOP was inaugurated in 1965 and its success in arranging meetings involving many disciplines besides physics led to the amendment of the name of the Group to 'The Vacuum Group'.

The Group continues its endeavours to represent those in the vacuum community and to appeal to as many as possible in academe, research and industry by arranging meetings covering the widest possible range of subjects. To this end the composition of the Group Committee reflects the broad coverage of the subjects aimed at by the Group, encompassing academics, representatives of vacuum manufacturers and vacuum users in government and industrial laboratories. The Group has been successful in bringing together those engaged in the production and improvement of vacuum equipment with those concerned with its application in such diverse areas as medical physics, large machines for research in the physical sciences, industrial process control and the electronics and semiconductor industries.

The Vacuum Group has approximately 600 members with 20% being outside the UK and Ireland. 35% are in the 18-24 age group range which bodes well for the future of the group!

The Group aims to organise a programme of half-day and full-day meetings, some of which have taken the form of workshops and included

mini-exhibitions. The group has also actively participated in the Vacuum Symposium UK series of conferences.

The Vacuum Group takes an active interest in education for those working with vacuum technology. The Group maintains close links with the British Vacuum Council (BVC), the International Union for Vacuum Science Technique and Applications (IUVSTA) and Vacuum Symposium UK.

2. Report of the Chair 2019-2020

It is a pleasure to write for the first time as Chair of the Vacuum Group. I took over from Dr Ron Reid at the start of October 2019 for a four-year term and I would like to thank Ron for all his hard work and stewardship of the group during his term of office.

During 2019 Group activities included the “Vacuum through the years” meeting as well as 3 other joint-meetings: details are later in the newsletter.

The committee membership has had a significant turnover in the last 18 months and I would like to thank the previous members of their work and contributions to the group.

I write this report during the Covid-19 pandemic which has clearly impacted significantly on the 2020 plans for the group and the entire Global Vacuum Community.

Unfortunately, this means the planned 2020 Training Course has been cancelled until 2021. As I write (August) the Vacuum Symposium VS11 has been cancelled, as has the American Vacuum Symposium originally scheduled for October.

The group continues to operate with remote committee meeting calls and making plans for events in 2021.

I hope you find the Newsletter of interest and I welcome any comments regarding this and the Vacuum Group as a whole.

Andrew Chew, August 2020

3. Vacuum Group Committee

The Vacuum Group Committee comprises 3 officers (Chair, Secretary and Treasurer) and up to 9 ordinary members and as required, up to 3 co-opted members.

Position	Membership_Grade	Salutation and name	Start Date	End Date
Chair	Fellow	EurPhys Dr Andrew Chew	01/10/2019	30/09/2023
Ordinary Member	Associate Member	Mr Robin Hathaway	01/10/2018	30/09/2022
Secretary	Fellow	Mr Robert Livesey	02/03/2017	30/09/2021
Ordinary Member	Member	Mr Nikeel Patel	01/10/2018	30/09/2022
Ordinary Member	Member	Dr Saim Memon	24/02/2017	30/09/2021
Treasurer	Member	Dr Gianfranco Claudio	01/10/2017	30/09/2021
Ordinary Member	Member	Dr Reza Valizadeh	01/10/2018	30/09/2022
Ordinary Member	Member	Dr Esmeail Namvar	01/10/2018	30/09/2022
Ordinary Member	Fellow	Dr Oleg Malyshev	01/10/2016	30/09/2020
Co-opted Member	Fellow	Dr Alan Webb	01/10/2019	30/09/2020

4. Report on 10th Vacuum Symposium 9-10th October 2019, Coventry, UK

https://www.vacuum-uk.org/

The 10th Vacuum Symposium UK was held at The Ricoh Arena in Coventry on the 9th and 10th October 2019. Several Symposia were held including *Vacuum Through the Years* which sought to encompass vacuum progress over the years with a focus on major milestones. The meeting was sponsored by the Institute of Physics Vacuum Group.

Dr Sunil Patel of STFC Rutherford Appleton Laboratory and Dr Andrew Chew of Atlas Copco Scientific Vacuum Division chaired the meeting.

Speakers presented historical progress from a wide range of vacuum technologies. Mike Thompson of Edwards gave a highly illuminating talk on the *History of dry pump applications in semiconductor processing* which charted the evolution of application challenges and customer requirements on vacuum pumps from the 1980s. The development and introduction of dry pumping and successive generations were discussed relevant to drivers of larger wafers (and gas flows), the reduction of power and pump size. Future trends included a discussion of the

continual introduction of new materials with associated new precursor and by-product challenges.

60+ years of ion pumps from invention to latest developments was presented by Mauro Audi of Agilent Technologies and chartered the history of ion getter pumps and their applications over the decades; the reduction in required power being especially highlighted. The latest developments were discussed including a new combination of magnetic field and cell dimensions to produce the first ion pump with pumping speed maximised in the low pressure range; minimization of charged particle emissions and a combination with NEG pumps.

Enrico Maccallini of SAES Getters presented *Non Evaporable Getters: evolution and experience of more than 40 years.* He discussed how NEG pumps have been developed since the 1970s and their adoption across industry, R&D laboratories and accelerators, with a special emphasis on the capability to -pump hydrogen. Recent developments in ZAO® alloy were shown with the benefit of extending to the high vacuum pressure range

Kris Haran of Pfeiffer Vacuum presented *Dry versus wet pumps – different dry pump principles*. The development of dry pumps having not reduced the ongoing popularity and application of OSRV wet pumps. The meeting was finished with a presentation by Jonty Bray of MKS Instruments who discussed the fascinating historical development of gauging over the last four centuries. The technologies and characters who developed them and the drivers for new gauging was greatly appreciated by the audience.

A poster session was held during the lunch interval and the *Harry Leck Memorial Medal for 2019* was presented to *Dr Alan Webb* for his significant contribution and understanding of plasma chemistry, plasma physics and thin films in both business and academic positions.

Other meetings included the *Structure and Dynamics of Surfaces and Interfac*es (with the BVC 60th anniversary presentation from 2019 IUVSTA Prize for Science winner Prof Phil Woodruff); *Thin Films and Coating Technologies for Science and Industry; 17th Technology Plasma Workshop* and *Surface Analysis- The Changing Composition at the Surface.*

Seven Vacuum Technology Training Courses were run for newcomers to the field as well as those wishing to expand their knowledge further

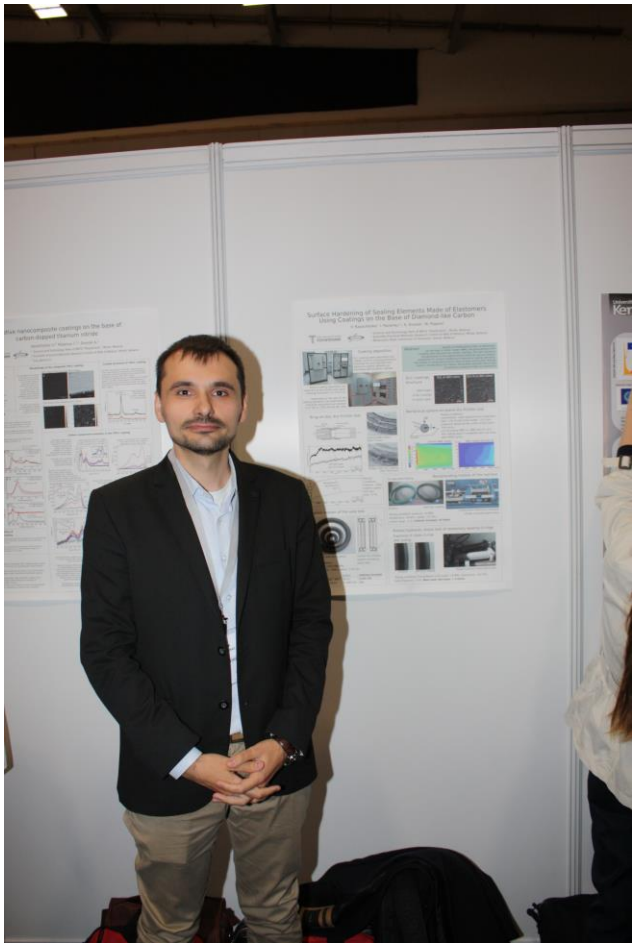
into UHV and techniques such as Leak Detection and Residual Gas Analysis. The aim of these courses is to lay the foundation for a more advanced course organised by the Vacuum Group on Vacuum System Design and Maintenance originally scheduled for June 2020 (this has since been cancelled).

The symposium was co-located with VacuumExpo https://vacuum-expo.com/. Nearly 40 companies exhibited from across the industry of vacuum techniques, products and applications.

Andrew Chew

2019 Vacuum Group Poster Prize

The winner of the 2019 IOP Vacuum Group Poster prize for posters presented at VS10 was Ihar Razanau of Laboratory of physical-chemical technologies Scientific-Practical Materials Research Centre of NAS of Belarus, Minsk, Belarus. The poster title was “Surface hardening of sealing elements made of elastomers using coatings on the base of diamond-like carbon”.



The Harry Leck Memorial Medal 2019

Each year the organising committee of Vacuum Symposium UK seeks nominations for the Harry Leck Memorial Medal. The Medal is awarded for distinguished contributions to British scientific research and/or related scientific/technical communities, in the field of Vacuum Science and Technology.

The medal has been established to honour the memory of **Professor John Henry Leck**, known to his friends as ‘Harry’. Harry was a former Chair of the IoP Vacuum Group.

VACUUM Group newsletter 2020

The winner of the 2019 Harry Leck Memorial Medal is Dr Alan Webb, Consultant.

Vacuum Symposium 2020 COVID-19 Announcement

The organising committee of Vacuum Symposium UK have been monitoring the current and on-going situation regarding COVID-19, along with government guidelines. In view of the seriousness and uncertainty around this deadly virus we have decided to postpone VS11 until 2021.

This was a difficult decision to take, but we had to consider the duty of care that we have along with the health and wellbeing of the VS family and all our supporters. Please keep looking on the VS website for news about VS11 and new and exciting content. Thank you to all our sponsors, trainers, meeting organisers and delegates who attend, we hope to see you again in 2021.

Stay safe and well.

Robin Hathaway

Vacuum Symposium UK (Chairman)

5. AVS 2019 report

Report on the American Vacuum Symposium, AVS 66th International Symposium and Exhibition

Columbus, OH, USA

The Annual Symposium of the American Vacuum Society is the world's main yearly vacuum conference held in Columbus, Ohio from the 20th to 25th October 2019.
There were 27 parallel sessions in a wide range of topics and over 2500 registrants

2D	2D Materials
AC	Actinides and Rare Earths Focus Topic
AP	Atomic Scale Processing Focus Topic
AS	Applied Surface Science Division
BI	Biomaterial Interfaces Division
BP	Biomaterials Plenary Session
CA	Chemical Analysis and Imaging Interfaces Focus Topic
DM	Fundamental Aspects of Material Degradation Focus Topic
EL	Spectroscopic Ellipsometry Focus Topic
EM	Electronic Materials and Photonics Division
EW	Exhibitor Technology Spotlight Workshops
HC	Fundamental Discoveries in Heterogeneous Catalysis Focus Topic
HI	Advanced Ion Microscopy and Ion Beam Nano-engineering Focus Topic
LS	Frontiers of New Light Sources Applied to Materials, Interfaces, and Processing Focus Topic
MI	Magnetic Interfaces and Nanostructures Division
MN	MEMS and NEMS Group
MS	Manufacturing Science and Technology Group
NS	Nanometer-scale Science and Technology Division
OX	Complex Oxides: Fundamental Properties and Applications Focus Topic
PS	Plasma Science and Technology Division
QS	Materials and Processes for Quantum Information, Computing and Science Focus Topic
RA	New Challenges to Reproducible Data and Analysis Focus Topic
SE	Advanced Surface Engineering Division
SS	Surface Science Division
TF	Thin Films Division
TL	Energy Transition Focus Topic
VT	Vacuum Technology Division

The summary of the program, abstracts of the papers presented and exhibition can be found in these links.
https://www2.avs.org/symposium2019/
https://www2.avs.org/symposium2019/ProgramBooks/ProgramBook_Complete.pdf
https://cdn.fs.pathlms.com/2eJTbzmgTpGxdALuqG1d

Materials and Outgassing

There were several papers discussing materials and outgassing. Martin Wuest of Inficon presented the results of the Atomic Layer Deposition of Al_2O_3 of all components of calibration vacuum chamber made from 304L stainless steel. ALD was chosen for its superior uniformity compared with PVD and plasma spray. This coating reduced outgassing rates by a factor of 40 to a value of 4e-13 mbar.l/s/cm^2. James Frederick of the National Institute of Science and Technology (NIST) presented work on the measurement of H_2 and water outgassing rates of 7 identical 3 litre chambers with different common vacuum materials and treatments. The outgassing rates were measured by the rate of rise method. Some of the major results showed that Ti may

actually getter hydrogen and that vacuum firing 316L stainless steel reduces its outgassing by a factor of 150. A conclusion was for XHV Al, Ti, vacuum fired 316L and 316L-LN ESR, and A36 mild steel were suitable materials. Maxwell Martin of the Jet Propulsion Laboratory presented the means to use quartz crystal microbalances to conduct *in-situ* monitoring of next-generation space exploration hardware.

Pressure measurements and calibration

NIST also presented work (Kevin Douglas) on the progress towards pressure measurements based on refractive index. A 'dual-wavelength' approach is being developed to provide primary traceability for the NIST Fixed Length Optical Cavity method. They also presented a paper (Jay Hendricks) describing the next generation of SI traceability of the Pascal. This will give an energy density definition using a photonics-based device exploiting 'both of the properties of light interacting with a gas and that the pressure dependent refractive index of helium can be precisely predicted from fundamental first-principles quantum chemistry calculations'. On the theme of calibration M-V Johansson of Aix Marseille University presented the application of micro-sintered stainless-steel membranes. They were found to give constant conductance for low pressure and with Capacitance manometers they can be used in combination with turbomolecular pumps to provide *in-situ* gauge calibration.

Pumping

Several reports were made on the use of Non Evaporable Getters (pumps and coatings) including at the CHESS facility, Argonne National Laboratory, LCLS II (SLAC) and APS-U. Yevgeniy Lushtak of CHESS-U reported on the synchrotron radiation induced vacuum conditioning status and *'the computational model developed to accurately simulate the vacuum conditions whilst taking into account the NEG saturationand radiation-induced chamber cleaning'.* Derek Hammar of Coe College presented a poster on the modelling of NEG pump operation during saturation. Junichiro Kamiya of the Japan Atomic Energy Agency described work, in collaboration with Osaka Vacuum and Tokyo Electronics Company Limited, on the development of an Osaka turbomolecular pump with Ti alloy (6% Al, 4% V). This has much

higher mechanical strength than aluminium alloys and allows a higher rotational speed of the rotors. A 30% increase was shown to increase the pumping speed by a factor of x 1.3 and compression ratio by x 12.5 (with theoretical improvements of x 1.8 and x 17 respectively).
Highlights of the poster sessions included the work of JEOL and KEK (Japan) on the application of NEG coatings to allow the transportation of UHV (electron microscope) systems without electricity.

Andrew Chew

6. The British Vacuum Council and BVC Prize

The Institute of Physics is a member of the British Vacuum Council and nominates two members of the Council.

The web site contains the BVC mission statement, remit, activities, events, members, the current committee, and a whole lot more! There is a leaflet to download, explaining the purpose of the BVC, that can be folded into a third the size of A4 and can be used at conferences and meetings for delegates to read. Additionally, there is a PowerPoint™ presentation of 'What the BVC is and what it does'. This can be further used as an educational tool to give a brief introduction to the history and 'workings' of the BVC.

The BVC offers two prizes annually; The British Vacuum Council Senior Prize (with associated John Yarwood Memorial Medal) and the British Vacuum Council Junior prize (which comprises the BVC Medal and C.R. Burch Award). Within the web-site there are lists of former recipients and details of how to nominate a candidate for a current prize. Nomination is always open which means that, if the deadline is missed one year, the nomination can be submitted the following year for consideration by the Committee. See it all here http://www.british-vacuum-council.org.uk/

Please consider making a nomination.

The BVC is your link to IUVSTA (The International Union for Vacuum Science, Technique and Applications), and the web-site is an ideal way to trace this link. The site can directly link you electronically to the IU-VSTA web site. The IUVSTA Divisional Representatives can be found,

who are your link to IUVSTA activities within your field, via the web-site http://iuvsta.org/
Alan Webb

7. Some Heroes of Vacuum

Fernand Holweck

The legendary French scientist Fernand Holweck was born in 1890 and made significant impact on a breath-taking range of activities which are still highly relevant today. He studied at the Ecole de Physique et Chimie and graduated in 1910 having been amongst such luminaries as Pierre Curie and Paul Langevin.

In 1912 he became an assistant to Marie Curie and played an intrinsic role in the development of the Curie Institute. He was an experimentalist par excellence and is credited with contributing more than anybody else to the systematization of the radioactive technique, which was created in the Curie Laboratory and spread thence throughout the world.

During the First World War he worked with Louis de Broglie on developing ultrasound techniques for the detection of submarines. In 1922 he received his Doctorate for his studies on soft x-rays, bridging the gap in understanding between the far ultraviolet region and x-rays: a classical study on the x-ray spectra of the elements of low atomic number. Amongst other contributions Holweck developed the gravimetric pendulum (for surveying), a demountable high-power radio tube, he worked on thermionic valves and a constructed the first successive acceleration X-ray tube cascade. He was also the first to develop the focusing of electrons and electron optics; in this respect he was at the forefront of the development of television.

In these latter activities his use of, and interest in improving, vacuum techniques was expanded. To this end he designed and built the Holweck molecular vacuum pump in 1920 achieving vacuum levels of 10^{-6} mbar, which contributed significantly towards vacuum-reliant research and industry. In the Holweck molecular pump the pumping action is produced by a rotor usually in the form of a smooth cylinder. The stator is provided with spiral guide grooves. The design of the construction can also be reversed, with the stator being smooth and the rotor having the guide grooves. The principle is one of the exploitation of molecular drag. Today there are still totally Holweck based pumps, but the Holweck principle is now used mainly in combination with bladed

turbomolecular pumps whereby the Holweck stage facilitates exhaust to high backing pressures and gives high process gas throughout. These pumps play a crucial and integral part in the vacuum techniques used in contemporary microelectronics production.

Holweck continued to use this pump for his research into x-rays and radio-biological applications at the Pasteur Laboratory. In 1929 he independently confirmed, the quantized interpretation of the biological action of radiation on microorganisms and later, on bacteria, fungi and viruses.

In 1938-1939, Holweck joined a group of French vacuum scientists from academia and industry to form the first national Vacuum Society aiming to promote vacuum sciences and techniques through education, which later became the 'French society for vacuum engineers and Technicians.'

During the German occupation of France in 1940 Holweck and his work were closely monitored. Although his personal safety was at high risk, he refused to leave Paris and joined the resistance. He was arrested by the Gestapo in December 1941 and died shortly after his arrest whilst under torture.

In 1945 the French and British Physical Societies, as a memorial to Fernand Holweck, initiated the Holweck medal. The award is presented alternatively by the Council of the Institute of Physics to a French physicist and by the Council of the French Society to a physicist based in the UK or Ireland. The selection is made from a list of three nominees submitted by the other Council.

Holweck's legacy to vacuum and science in general is undisputable however it is maybe best to leave the final words to one of his obituarists writing in 1942 in Science (Vol. 96 No. 2493 p33) 'He has paid with his life for his love for freedom and for his country. His example will inspire all scientists of the world in their fight for the cause of liberty and democracy'.

https://www.iop.org/about/awards/bilateral/holweck/page_38477.html

Andrew Chew

Mahne Siegbahn

Karl Manne Georg Siegbahn was a Swedish physicist who won the Nobel Prize for Physics in 1924 "for his discoveries and research in the field of X-ray spectroscopy." Remarkably his son (Kai Manne Börje), in 1981 also won the Nobel Prize for Physics "for his contribution to the development of high-resolution electron spectroscopy".

Siegbahn senior's very early work focused on problems of electricity and magnetism. He worked at Lund University with Rydberg and on whose death he became Professor in 1920. Siegbahn moved in 1923 to a Physics chair at the University of Uppsala and he was later (1937) to become Research Professor of Experimental Physics at the Royal Swedish Academy of Sciences. In the same year he became the first Director of the newly formed Physics Department of the Nobel Institute of the Academy.

From 1912 onwards Siegbahn focused his studies onto X-ray spectroscopy. He was to develop novel techniques and practices (e.g. X-ray tubes and gratings) which enabled increasing radiation intensity and increased accuracy of measurements. In 1916 he discovered the 3rd (M series) group of spectral lines. Siegbahn's later work at the Institute was to oversee the development of a cyclotron for nuclear physics research.

Siegbahn utilized vacuum for his experiments and his search for higher vacuum levels led to his development of the Siegbahn Pump. This was a drag type mechanism which different from the Gaede and Holweck pumps in that a disc rotates inside a housing with spiral grooves. Patents were sought a few years after the pump was first built in 1926. It is not know whether Siegbahn was aware of the patent on the Holweck drag pump From 1926-1940 units were built in the university machine shop and Leybold held a licence for production up to 1931.

The first pumps were relatively small, 220 mm diameter, with and ultimate of 1e-5 mbar and fore-pressure of 0.1 mbar. Its pumping speed was only 2 l/s. After further development a pump with 30 l/s speed was produced in 1943. Siegbahn was later to describe a hybrid Seigbhan-Gaede mechanism of speed 48 l/s.

A large pump (disc diameter 540mm) was built for the cyclotron at the Nobel Institute which had 3 spiral grooves (in parallel) and a pumping speed of 73 l/s.

Generally the Holweck mechanism is more widely employed in drag pumps or drag stages of a turbomolecular pumps. Since the Siegbahn pump is a series of discs rather than cylinders it gives a more compact pump. In this case although the Holweck mechanism is more efficient the Siegbahn has more stages and this gives increased performance.

Reference:

http://nobelprize.org/nobel_prizes/physics/laureates/1924/siegbahn-bio.html

Andrew Chew

Marcello Stefano Pirani

Born of Italian descent in Berlin in 1880, Marcello Pirani was destined to make a major input to vacuum technology at a very early age. He completed his studies in Mathematics and Physics and then postgraduate research in 1904, thereafter joining the Siemens & Halske (Gluhampenwerk) incandescent lamp factory. He was mainly concerned with sources of light but also the manufacture of tantalum lamps, the manufacture of which required a higher vacuum than carbon filament lamps.

A particular problem was in the use of glass McLeod gauges for vacuum measurement. They presented problems in being both manually operated and particularly sensitive to breakage; spilling poisonous mercury when doing so. Pirani considered this problem and as a result in 1906 he published his paper entitled the ‘Directly Indicating Vacuum Gauge’ which became known as the ‘Pirani gauge’: the first automatically reading gauge.

The Pirani gauge was designed to measure low pressures by utilizing the variation of heat loss from a wire with the surrounding pressure. A heated metal filament (typically platinum in modern gauges) loses heat to the gas from collisions of gas molecules with the wire. The heat loss is dependent on the number of collisions made with the wire and hence the pressure/density of the gas. As the vacuum level increases the number of molecules present will fall proportionately. This has a reduced cooling effect for the wire.

The electrical resistance of a wire varies with its temperature. The Pirani gauge operates in one of three modes: constant voltage, constant current or constant resistance (i.e. temperature). The Wheatstone bridge

circuit is usually used where the Pirani gauge filament is one arm of a four-armed bridge. The readings of the gauge have to be corrected or calibrated for different gases (which have different thermal conductivities). Compared to the McLeod gauge the Pirani Gauge has the advantage of being automatic. Modern day Pirani gauges can measure from 100/10 to 10^{-4} mbar with an extension to higher pressure by exploiting the pressure dependence of convection losses.

Pirani worked further on optical measurements of high temperatures and then joined Osram in 1919 as head of the scientific-technical bureau. There he researched widely on topics ranging from the sorption of gases by tantalum to the transition from incandescent to gas-discharge lamps. During his time in industry he held several positions at the Technical University and Technishe Hochschule, both in Berlin.

From 1936 Pirani woked in the UK on activities as varied as high temperature resistant materials to the utilization of fine coal dust. He returned to Germany in 1953 consulting for Osram before dying at the age of 88 years in the city of his birth.

Andrew Chew

8. A Short Review on "Vacuum Science World – Portal of Expertise for Vacuum Technology"

https://www.vacuumscienceworld.com/

O.B. Malyshev,

Lead scientist on vacuum science and technology,

STFC Daresbury Laboratory, Warrington, Cheshire.

A large number of good books on vacuum science and technology has been published. Thus, Dr. B.R. Kendall has prepared a list of 136 book titles; the International Union for Vacuum Science, Technique and Applications (IUVSTA) has published it on its website [i]. A few more books were published in recent years to represent a modern level of knowledge in the rarefied gas dynamics and modelling, design of

vacuum system and vacuum technology, vacuum instrumentation and materials. However, we often need a quick access to some essential information and there is no vacuum handbook available. In this case, Vacuum Science World https://www.vacuumscienceworld.com/ could be a good source of information. Vacuum Science World is a web portal with a lot of useful information related to various aspects of vacuum science and technology. This portal was initiated, built and regularly updated by vacuum experts: Dr. Andrew Chew, Dr. Peter Lambertz, Dr. Saim Memon and Prof. Dieter Mueller.

The information available there can be useful for education reading for those who is new in vacuum as well as for experienced scientists, engineers, technicians and students who operate and/or design vacuum systems.

The Vacuum Science World Portal has a few sections.

Vacuum Science section covers basics of vacuum science: terminology, units, basics of gas dynamics, means of vacuum generations (vacuum pumps) and measurements (vacuum gauges). It also covers two critical fields in vacuum technology: Leak detection and Residual gas analysis. All this information is essential to operate any vacuum equipment.

Knowledge hub provides links to Vacuum system design, Evacuation calculator, Vacuum facts and stories, a blog with a number of articles and Vacuum Science World Resources with links to vacuum e-books. A number of practical frequently asked questions are answered in series of videos: *Ask Dr. Chew*. This section also presents oncoming events related to various Vacuum science, technology and applications.

Finally, a section **Ask an Expert** could be very useful for someone who is struggled with a vacuum related problems, he/she can get a hand by filling a simple on-line form, and the Vacuum Science World experts will be happy to help in solving the problem.

Thus, Vacuum Science World is a useful educational and information portal for all things relating to vacuum science, technology, application and industry. The portal is still further developing. It provides a platform for researchers, engineers, scientists and students to

collaborate, network and share knowledge on vacuum science and technology.

The vacuum experts who is maintaining this portal are also seeking for other enthusiastic contributors who will provide any type of educational and practical information, trainings, videos, etc. for sharing at this portal.

[1] B R Kendall. Textbooks on vacuum science and technology published, 1922-2003. IUVSTA web site: https://iuvsta.org/iuvsta-publications/, last accessed on 01/08/2020.

9. Forthcoming events

ECOSS 35 European Conference on Surface Science, 23-28 August 2020
https://ecoss2020.uni.lu/
Postponed to Summer 2021

Vacuum Symposium VS11 October 7-8, 2020
https://www.vacuum-uk.org/
Cancelled
Replaced by Digital forum 6-8 October 2020
https://spie.org/conferences-and-exhibitions/photonex-and-vacuum-expo?utm_id=zpx20cve&spMailingID=5820520&spUserID=MjU4MTg0MzE1Nzc1S0&spJobID=1080381688&spReportId=MTA4MDM4MTY4OAS2

AVS 67th International Symposium and Exhibition October 25-30, 2020
https://www.avs.org/Symposium/Call-For-Abstracts
Cancelled
Replaced by AVS virtual showcase **October 27-29, 2020**
https://avs67.avs.org/

ICTF-JVC 2020: 18th International Conference on Thin Films &
18th Joint Vacuum Conference, Budapest, 22-26 November 2020
https://akcongress.com/ictf-jvc/

European Vacuum Congress EVC16, Marseille, France
30 May -4 June 2021
https://www.evc16.org/

22nd International Vacuum Congress IVC-22, Sapporo, Japan
11-16 September 2022
https://ivc22.org/

Join the Vacuum Group!

The Group welcomes new members.
If you are already a member of the IoP, then go to your MyIOP page and simply sign up. **It will not cost you anything extra**! Alternatively follow the instructions on http://www.iop.org/activity/groups/page_38363.html

If you are not yet a member of the IoP then go to https://membership.iop.org/become-a-member and follow the links there to get full information.

The Institute of Physics, 37 Caledonian Road, London N1 9BU UK.
Tel: 020 7470 4800
Email: physics@iop.org
Web: www.iop.org