

CHEMISTRY

IN SRI LANKA

CHEMEX - 3
Exhibition January 22-24, 2014

Practical Demonstrations

Chemistry Magic Shows

Physical Chemistry

Environmental Chemistry

Industrial Chemistry

Pharmaceutical Chemistry

Agro Chemicals

Analytical Chemistry

Food Chemistry

Natural Products

Organic Chemistry

Polymer Chemistry

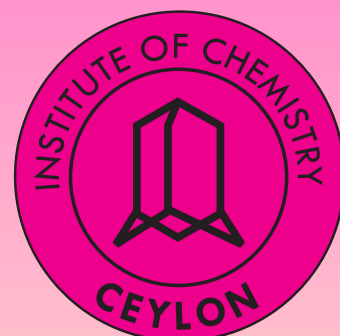
Inorganic Chemistry

Nano Chemistry

Innovation Stall

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Institute of Chemistry Ceylon
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Chemistry in Sri Lanka

ISSN 1012 - 8999

The Tri-Annual Publication of the Institute of Chemistry Ceylon

Founded in 1971, Incorporated by Act of Parliament No. 15 of 1972

Successor to the Chemical Society of Ceylon, founded on 25th January 1941

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January 2014

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Theme for the year -

Curricula and Evaluation in Chemistry for a Sustainable Economy

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Outline of our Institute

The Institute of Chemistry Ceylon is a professional body and a learned society founded in 1971 and incorporated by act of Parliament No. 15 of 1972. It is the successor to the Chemical Society of Ceylon which was founded in 1941. Over 50 years of existence in Sri Lanka makes it the oldest scientific body in the country.

The Institute has been established for the general advancement of the science and practice of Chemistry and for the enhancement of the status of the profession of Chemistry in Sri Lanka. The Institute represents all branches of the profession and its membership is accepted by the government of Sri Lanka (by establishment circular 234 of 9-3-77) for purposes of recruitment and promotion of chemists.

Corporate Membership

Full membership is referred to as corporate membership and consists of two grades: **Fellow (F.I.Chem.C.)** and **Member (M.I.Chem.C.)**

Application for non-corporate membership is entertained for four grades: **Associate (former Graduate) (A.I.Chem.C.)**, **Licentiate (L.I.Chem.C.)**, **Technician (Tech.I.Chem.C.)** and **Affiliate Member**.

Revision of Membership Regulation

All Special Degree Chemists can now apply directly to obtain **Associate (Graduate) Membership**. Three year B. Sc. Graduates (with an acceptable standard of Chemistry) can

- directly become **Licentiate**
- obtain corporate membership in a lesser number of years.

Tech.I.Chem.C.

Those who have passed the DLTC examination or LTCC examination or have obtained equivalent qualification and are engaged in the practice of Chemistry (or chemical sciences) acceptable to the Council are entitled to the designation **Tech.I.Chem.C.**

Members/Fellows are entitled to the designation of **Chartered Chemist (C.Chem.)** on establishment of a high level of competence and professionalism in the practice of chemistry and showing their commitment to maintain their expertise.

All corporate members (Members / Fellows) are entitled to vote and become Council/ Committee members whether Chartered Chemists or not.

Membership Applications

Any application for admission to the appropriate class of membership or for transfer should be made on the prescribed form available from the Institute Office.

Current Subscription Rates

Fees should be paid on 1st of July every year and will be in respect of the year commencing from 1st July to 30th June

Fellow	Rs. 1200
Member	Rs. 1200
Associate	Rs. 900
Licentiate	Rs. 750
Technician	Rs. 500
Affiliate	Rs. 500
Membership for Life	Rs. 10000

Entrance Fee

All the grades	Rs. 500
Processing Fees*	Rs. 200
Processing Fee for Chartered Chemist designation	Rs. 1000
Institutional Members	Rs. 2500

*per application for admission/transfer to any grade

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CHEMISTRY IN SRI LANKA

Chemistry in Sri Lanka is a tri-annual publication of the Institute of Chemistry Ceylon and is published in January, May and September of each year. It is circulated among the members of the Institute of Chemistry and students of the Graduateship/DLTC course and libraries. The publication has a wide circulation and more than 1500 copies are published. Award winning lectures, abstracts of communications to be presented at the annual sessions, review papers, activities of the institute, membership news are some of the items included in the magazine.

The editor invites from the membership the following items for publication in the next issue of the Chemistry in Sri Lanka which is due to be released in May 2014.

- Personal news of the members
- Brief articles of topical interests
- Forthcoming conferences, seminars and workshops
- Latest text books and monographs of interest to chemists

All publications will be subjected to approval of the 'Editorial and Publicity Committee' and the Council of the Institute of Chemistry Ceylon.

Further, prospective career opportunities for chemists, could be advertised in Chemistry in Sri Lanka at a nominal payment. The editor welcomes from the members suggestions for improvement of the publication.

Editorial

The Institute of Chemistry Ceylon is now in its 43rd year (73rd year of its predecessor, the Royal Society of Chemistry) showcasing its considerable achievements, especially in the Professional Chemistry Education programmes. The establishment of the College of Chemical Sciences in 2001, during the Diamond Jubilee year of the Institute, paved the way for the consolidation of the educational programmes. Taking the progress made into consideration, this year's activities are mainly centred on "Education". This year marks the completion of the 40th year of the commencement of the Professional Education programmes at the Institute. The "*Diploma in Laboratory Technology in Chemistry*" (DLTC), the first established Professional Education programme commenced in 1973 and has so far produced about 1000 middle level Professional Laboratory Technicians. They are gainfully employed, serving government and non-government institutions. The second Professional Chemistry Education programme the "*Graduateship in Chemistry*" (GIC) also commenced in the 1970s and has produced a similar number of Graduate Chemists serving nationally and internationally. The annual increase in the number of students registering for these two programmes is a testament to the success of these two professional education programmes.

To celebrate the 40th Anniversary of the establishment of the DLTC programme an International Conference on the theme, "*Chemical Education and Research for Industrial Development & Sustainable Growth in a Knowledge Based Economy*" is being organized on 3rd & 4th April 2014. World renowned chemists are participating in this conference giving Inaugural and Plenary lectures. The participation of a large number of national and international chemists and educationists is also expected. In addition to this event, an exhibition

displaying the achievements in Chemistry, 'CHEMEX-3' is being organized from 22nd-24th January 2014, at the Institute of Chemistry Headquarters, the Adamantane House for the student community and the general public.

Another significant development in the Institute is the construction of an extension to the existing building to provide the additional space and facilities required for the two educational programmes. The expansion will provide adequate space to improve the facilities at the College of Chemical Sciences enabling the 600-700 students at the Institute to have a more conducive learning environment. This expansion will also help to improve the research capabilities at the Institute.

The theme for this year's Annual Sessions "*Curricula and Evaluation in Chemistry for a Sustainable Economy*" is also centred on 'Education'. The Inauguration, the Theme Seminar and the Technical Sessions will be held from 18th - 20th June 2014. This will provide us an opportunity to learn more about the important aspects of curriculum development and evaluation which form the core issues of any teaching programme in Chemistry. This event will greatly help the teaching programmes of the College of Chemical Sciences.

While upgrading the facilities of the College of Chemical Sciences from its earnings, it is also important to create an environment for the general membership to take part in the activities of the Institute. Over the years it is observed that the members do not participate voluntarily in the activities of the Institute. Much persuasion is needed to get even a few members involved! Poor participation of members at the Annual Sessions, the most important event of the Institute, is noted with regret. Would the members kindly provide answers to this lack of interest in the Institute? We eagerly await your response!

Cover Page

Titles of the activities planned for the CHEMEX - 3 Exhibition organised on 22nd - 24th January 2014 to celebrate the Ruby anniversary of the commencement of the professional education programmes at the Institute of Chemistry Ceylon.

Nuclear imaging: the role of ^{99m}Tc agents

Theshini Perera

Senior lecturer, Department of Chemistry, University of Sri Jayewardenepura

George de Hevesy is widely credited for his contribution towards tracking the fate of a substance in the human body. The anecdote to this is quite humorous in that he is believed to have spiked the leftovers in his plate with radioactive material to prove that the indigestion he was having was due to his landlady recycling leftovers from his plate! George de Hevesy received the Nobel Prize in Chemistry in 1943 for his contribution to the use of isotopes as tracers in the study of chemical processes. Decades of follow up research and development has unveiled further implications of Hevesy's finding; if a fate of a substance can be traced through metabolic pathways, radionuclides can be traced to the cells or organs where it passes through.

Nuclear imaging is widely used in diagnostic technique from detecting malignancies to identifying metabolic disorders. In nuclear imaging, unlike in X-ray, the radioactive tracer material is internalized and the emitted radiation is captured by a scintillation camera. A radiologist can then study the images and make recommendations for therapy. One of the main advantages of nuclear imaging is its applications in real-time imaging where the function of an organ can be assessed while the radionuclide is in motion. Valuable diagnostic inferences can be ascertained through this process that a static image cannot provide.

Fusion of nuclear imaging techniques with other imaging techniques has produced sophisticated three dimensional real-time images that can couple anatomy with function of organs (Figure 1) which has made certain painful invasive techniques obsolete in diagnostic medicine. Co-registration imaging techniques, such as SPECT/CT (single positron emission computed tomography coupled conventional X-ray CT) can precisely locate malignancies with respect to other complex anatomical structures.

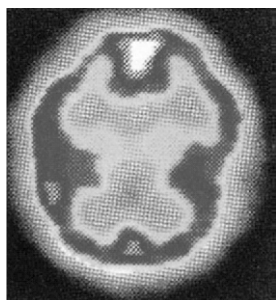


Figure 1. A transaxial scan of a normal brain. Reproduced with permission from Amersham international.

Properties of some nuclides used in nuclear imaging along with their current applications are shown in **Table 1**. Although there are many isotopes which are used in nuclear imaging, the most prominent are ^{99m}Tc agents which are metallo-radiopharmaceuticals.

Table 1. Properties of some nuclides used in nuclear imaging agents

Radionuclide	Half life	Emission	Medical use
^{18}F -fluorine	2 hours	beta	Imaging brain tumours
^{99m}Tc	6 hours	gamma	Imaging of many organs including heart, bone, muscle, gall bladder, etc
^{125}I -iodine	60 days	beta	Evaluation of kidney filtration
^{131}I -iodine	8 days	gamma and beta	Treatment of thyroid cancer and imaging

Organometallic complexes used as a nuclear imaging agents need to possess some desired characteristics; they must be safe to the subject, be able to be synthesized rapidly and conveniently in physiological media, and must result in products of high radio chemical purity.

As reported in Chemical and Engineering News, ^{99m}Tc is used in more than 80% of routine nuclear imaging tests. In the United States alone, 50,000 routine imaging tests are carried out per day using the ^{99m}Tc isotope. The wide usage of ^{99m}Tc as a radioisotope in nuclear medicine is due to its many attributes; notably that it has a half life is 6h, is conveniently available from a generator and is a gamma emitter of 141 keV.

Two approaches are used in the synthesis of ^{99m}Tc agents: the integrated approach and the bio conjugation approach where the agent is conjugated to a bio molecule (details of which are given in the latter part of this article). An example for integrated ^{99m}Tc agents is ^{99m}Tc -Sestamibi which is a coordination complex consisting of the radioisotope technetium-99m bound to six methoxyisobutylisonitrile ligands and is used to image the heart (Figure 2). Other examples include Ceretac, which is used to image the brain.

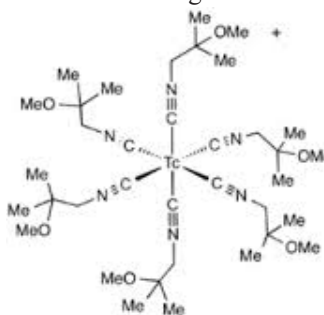


Figure 2. Line drawing of technetium (^{99m}Tc) sestamibi

Recent research has progressed in leaps and bounds mainly due to the introduction of a kit formulation for Tc^{I} radiopharmaceuticals based on the $\text{fac-}\{^{99\text{m}}\text{Tc}^{\text{I}}(\text{CO})_3\}^+$ core. This kit currently marketed by GE has been largely involved in developing a new class of radiopharmaceuticals based on the $\text{fac-}\{^{99\text{m}}\text{Tc}^{\text{I}}(\text{CO})_3\}^+$ core because the synthesis of $^{99\text{m}}\text{Tc}$ agents in aqueous medium from $\text{fac-}[^{99\text{m}}\text{Tc}(\text{CO})_3(\text{H}_2\text{O})_3]^+$ is now convenient. Also of tremendous importance in this aspect is the simulation of the synthesis of $^{99\text{m}}\text{Tc}$ agents in solution by non-radioactive $\text{Re}(\text{CO})_3$ complexes.

There are numerous examples in literature where synthetic conditions have been optimized using the non radioactive isotope of rhenium, the structure elucidation carried out and solution properties assessed before the radioactive $^{99\text{m}}\text{Tc}$ agents are synthesized. This approach is called the rhenium tricarbonyl analogue approach and is widely used.

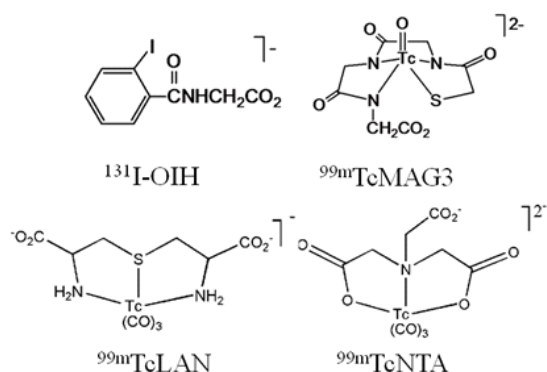


Figure 3. Line drawings of some renal imaging agents

Receptor specific targeting is a popular approach where cells are selectively targeted. Alberto and co-workers have brought a new dimension to this field by proposing a tri functional approach which demonstrates the individual steps required for targeting the nucleus of a specific cell type with $^{99\text{m}}\text{Tc}$ and with rhenium (**Figure 4**). A bifunctional nucleus-targeting molecule is able to carry the metal complex into its target. A trifunctional molecule, which contains, in addition, the receptor binding peptide bombesin, has been shown to be only taken up by cells containing the respective receptor in human prostate cancer cells.

NNN tridentate donor ligands have been found to be robust and has shown fast clearance from organs and tissue and hence utilized in the bioconjugation approach of $^{99\text{m}}\text{Tc}$ agents. Desbouis and co-workers have recently demonstrated that $^{99\text{m}}\text{Tc}$ complexes of thymidine appended ethylene diamine ligands can

serve as potent agents to selectively target and image proliferating cancer cells because these complexes accumulate in hK1 (human thymidine kinase 1) cell proliferation sites. hK1 is a cytosolic enzyme which is known to accumulate in rapidly proliferating and malignant cells and thus may be used to selectively target cancer cells.

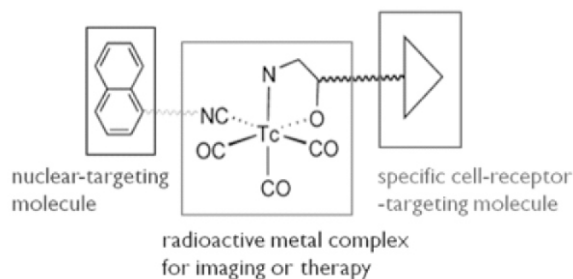


Figure 4. Schematic representation of a trifunctional radiopharmaceutical, adapted from work by Roger Alberto and co-workers

Also of importance in targeted imaging to aid in diagnosis are $^{99\text{m}}\text{Tc}$ -porphyrin complexes. A novel $^{99\text{m}}\text{Tc}$ labeled porphyrin has been found to be a potential agent for specific imaging of sarcoma cells. Novel water soluble $^{99\text{m}}\text{Tc}(\text{I})$ - $\text{Re}(\text{I})$ porphyrin conjugates have recently been found to be useful multimodal agents for nuclear imaging. A tertiary sulfonamide linkage has been recently utilized to conjugate the $\text{Re}^{\text{I}}(\text{CO})_3$ moiety to a novel tetraaryl porphyrin which has potential to be extended to $^{99\text{m}}\text{Tc}$ agents.

In conclusion, nuclear imaging is a largely versatile technique which is still evolving to deliver better functional imaging agents with better resolution and the focus has shifted to correlate *in vivo* nuclear imaging of $^{99\text{m}}\text{Tc}$ agents with *in vitro* fluorescence imaging utilizing isostructural $\text{Re}^{\text{I}}(\text{CO})_3$ complexes. Thus, it is apparent that there is tremendous scope for future research in this emerging field of metalloradiopharmaceuticals.

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Call for Nominations for Institute of Chemistry Gold Medal 2014 by 31st March (Under Revised Rules)

This Gold Medal was the very first of such awards to be donated to the Institute and was made possible through a generous donation made by **Mascons Ltd** in memory of their founder **Mr A Subramaniam** in 1978/79. It recognised contributions made to National Development through research and development involving Chemical Sciences. The Gold Medal Fund was supplemented recently through a further contribution from Mascons Ltd. This criteria governing the award were changed in 2011 since there were no applicants since 2007 in order to enable the award to be made to a mid-career Chemist in recognition of honorary services to the Institute.

Nominations are now being invited for the 2014 Award from amongst **Corporate Members** of the Institute who have fulfilled the following minimum criteria;

- Nominees should be not more than 55 years of age and should have been Corporate members of the Institute for at least 10 years on 1st of June 2014
- Nominees should have made significant contributions towards the activities of the Institute through yeoman services in an honorary capacity during the period of membership. These activities could include holding office, membership in committees, coordination of events such as workshops, social events etc.

Nominations could be made by any **corporate member** of the Institute and should include the consent of the nominee and details of the contributions made by the nominee in accordance with the above guidelines. The Award will be presented at the 43rd Annual Sessions. **Nominations should be forwarded to reach the Hony. Secretary, IChemC not later than 31st March 2014.**

Boron and Boron hydrides

Dr. T Gobika

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Boron

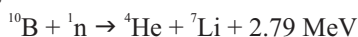
Boron was discovered in 1808 by J. L. Thenard and J. L. Gay-Lussac in Paris, France, and Sir Humphry Davy in London, UK^[1]. The name is derived from Arabic 'buraq'. It is the element next to carbon and in group 13 of the periodic table with the ground state valence electronic configuration $2s^2 2p^1$. It is the only element other than carbon that exhibits an extensive series of molecular hydrides.

It shows borderline properties between metals and non metals. Boron forms several commercially important compounds such as sodium borate pentahydrate ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 5\text{H}_2\text{O}$), boric acid (H_3BO_3) and Sodium borate decahydrate ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$) (better known as borax).

Boron containing compounds are used in the sodium perborate bleaches, manufacture of fiberglass insulation and textile fibreglass and cellulose insulation as a flame retardant. They are also used in laundry products, as mild antiseptic, enamels for covering steel and as a potential medicine for treating arthritis.

It is also used in the field of wood preservation. Moderate concentrations of borates can inhibit the growth of wood-destroying fungi and repel attacks by wood-boring insects, such as termites, carpenter ants and beetle larvae^[2].

Boron is the only light element with two abundant naturally occurring isotopes ^{10}B and ^{11}B with abundance 19.8% and 80.2% respectively. ^{10}B has an exceptionally high cross section for the capture of thermal neutrons which leads to the application of boron neutron capture therapy (BNCT) in the treatment of cancer. This process is based on the following nuclear reaction.



Carboranes, $\text{C}_2\text{B}_n\text{H}_{n+2}$ are remarkably thermally stable with the size of the framework and with increasing mutual distance of both carbon atoms. The closed shell structures of carboranes contribute to their chemical inertness therefore carboranes are not attacked by hot H_2SO_4 and HNO_3 .

Polyhedral polyborate ions, $\text{B}_n\text{H}_n^{2-}$ and heteroatomic polyhedral ions, $\text{CB}_n\text{H}_{n+1}^-$, bisdicarbollidemetalates(-) are non protonizable and

the hypothetical conjugated acids are extremely strong which are comparable to and probably surpassing such acids as hydrochloric acid, sulphuric acid and even perchloric acid.

Boron cluster species are very expensive, nevertheless very convenient and easily modifiable source of boron for e.g for advanced boron-based ceramics and for doping the semiconducting elements where boron behaves as an electron hole.

Deltahedral boron cluster anions are stable electrolytes in nonaqueous solvents. Boron cluster compounds are effective homogenous catalysts in hydrogenations, hydrosilylations and isomerisation of unsaturated organic species. Most importantly, metallocarboranes for e.g cobalt bis(1,2-dicarbollide) are useful in the fight against HIV^[3].

Boron Hydrides

The simplest compounds of boron are the boron hydrides and are composed of boron and hydrogen, and these are also called boranes. Boron hydrides are based on polyhedral clusters of boron atoms and these borane clusters are characterised by triangular faces, and such polyhedral are known as deltahedra. In 1933^[4] Alfred Stock first synthesised and characterised a series of boranes from B_2H_6 to $\text{B}_{10}\text{H}_{14}$ which fell into the two distinctive series of B_nH_{n+4} and B_nH_{n+6} .

The simplest boron hydride was not BH_3 because that would have two electrons fewer than required to satisfy the octet rule. This led to the concept of the electron deficient three-centre, two-electron bond developed by Longuet-Higgins^[5] in 1948. Therefore the simplest boron hydride is B_2H_6 and the stoichiometry is similar to C_2H_6 . B_2H_6 possesses only 12 valence electrons (3 from each B and 1 from each H) or 6 pairs therefore it has insufficient electrons to form 2-center, 2-electron bonds between every adjacent pair of atoms therefore the boranes were said to be 'electrons deficient' this meant that the bonding in B_2H_6 and C_2H_6 are different.

A few years later the structure was confirmed by Lipscomb by X-ray diffraction when he successfully obtained a crystal structure^[6] of B_2H_6 (figure 1)

The basket-like structure of the much larger boron hydride, decaborane, $\text{B}_{10}\text{H}_{14}$ ^[7] (figure 2) was characterised in the 1950s by Harker.

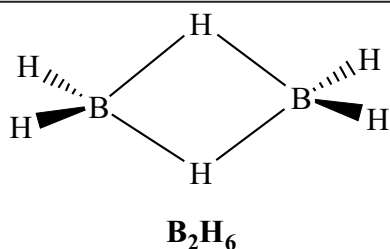


Figure 1 The structure of B_2H_6

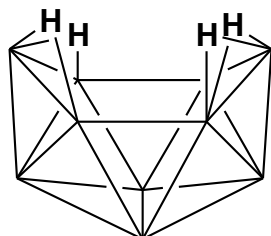


Figure 2 The structure of decaborane

Longuet-Higgins^[8] used molecular orbital (MO) calculations to predict the geometry of the 12 vertex $[\text{B}_{12}\text{H}_{12}]^{2-}$ in 1954, as icosahedral (figure 3) and in 1960 Hawthorne and Pitochelli^[9] confirmed the closed polyhedral structure of this dianionic species.

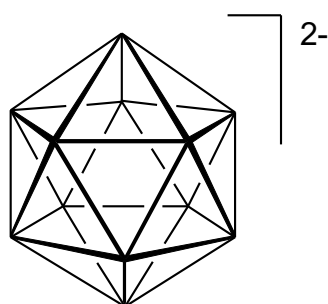


Figure 3 Structure of $[\text{B}_{12}\text{H}_{12}]^{2-}$

Bonding Theories

Various attempts were made to find a bonding scheme to predict borane structures. Lipscomb extended the 3-centre, 2-electron model proposed by Longuet-Higgins and developed *styx*^[10] rules in order to develop a general method. He used as a combination of 3-center, 2-electron *s* BHB, *t* BBB bonds and 2-centre, 2-electron *y* BB and *x* BH bonds to explain some borane structures.

If a boron hydride has the formula B_nH_{n+m} it was noticed that the *n* boron atoms and *m* (endo) hydrogen atoms lay on an inner-spherical surface. In the outer sphere the remaining *n* (exo) hydrogen atoms lay attached to the boron atom by 2-centre, 2-electron BH bonds which radially pointing outwards from the cluster centre. The boron and the endo hydrogen atoms involve bonding with $(2n+m)$ electrons: two from each BH unit and one from each hydrogen atom. A set

of equations were derived linking the values of *s*, *t*, *y* and *x* to *n* and *m*:

$$s = m - x = n - t = 2y + x$$

This theory is acceptable for the smaller boranes but when trying to explain structures of larger boron hydrides it breaks down.

A superior approach to understanding the bonding in delocalised cluster molecules was provided by Wade and extended by Williams and Mingos. Wade's rules^[11] were developed in 1971 which have several advantages over the *styx* method such as they are quicker and easier to apply, have a firm basis in molecular orbital theory, and apply also to heteroboranes and other clusters such as main group or low valency transition metal clusters. These rules are electron counting rules to predict the electron deficient structures based on polyhedra in which every face is triangular.

The number of electrons in the framework bonding electron pairs must be calculated in order to predict the structure. For a main group atom the total number of skeletal framework electrons is calculated by the following equation:

$$s = v + x - 2$$

v = number of valence electrons from the vertex atom (e.g. 3 for B)

x = number of electrons from exopolyhedral groups or atoms (e.g. 1 for H)

s and *x* are not the same as *s* and *x* in *styx*.

The value of *s* is the number of electrons available for bonding within the cage structure; dividing this value by two gives the total number of electron pairs that contribute to the overall shape. This is called the number of *Polyhedral Skeletal Electron Pairs* (PSEPs).

For a transition metal vertex

$$s = v + x - 12 \text{ (for 18e species)}$$

$$s = v + x - 10 \text{ (for 16e species)}$$

The number of PSEP's is related to the number of vertices (*n*) present in the polyhedron enabling the structure to be predicted using the following rules:

Number of SEPs	Geometrical pattern	
(<i>n</i> +1)	<i>closo</i>	closed parent polyhedron
(<i>n</i> +2)	<i>nido</i>	open polyhedron – one vertex removed
(<i>n</i> +3)	<i>arachno</i>	open polyhedron – two adjacent vertices removed
(<i>n</i> +4)	<i>hypho</i>	open polyhedron – three adjacent vertices removed

The *nido*, *arachno* and *hypho* structures are related to the *closo* parent polyhedra by the successive removal of the most highly connected vertices. The

nido structure is created by removal of the highest connected vertex from the *closo* structure and subsequently the *arachno* structure is created by removal of the highest connected open faced vertex from the *nido* structure and so on. This structural relationship exists due to the constant number of shape determining skeletal electrons and is illustrated in the Wade-Williams-Rudolph structural matrix (figure 4)^[12].

PSEP theory can be rationalised in terms of MO theory and is based on the fact that:

<i>Closo</i>	n-vertex polyhedra require (n+1) PSEPs to fill (n+1) skeletal BMOs
<i>Nido</i>	n-vertex polyhedra require (n+2) PSEPs to fill (n+2) skeletal BMOs
<i>Arachno</i>	n-vertex polyhedra require (n+3) PSEPs to fill (n+3) skeletal BMOs
<i>Hypho</i>	n-vertex polyhedra require (n+4) PSEPs to fill (n+4) skeletal BMOs

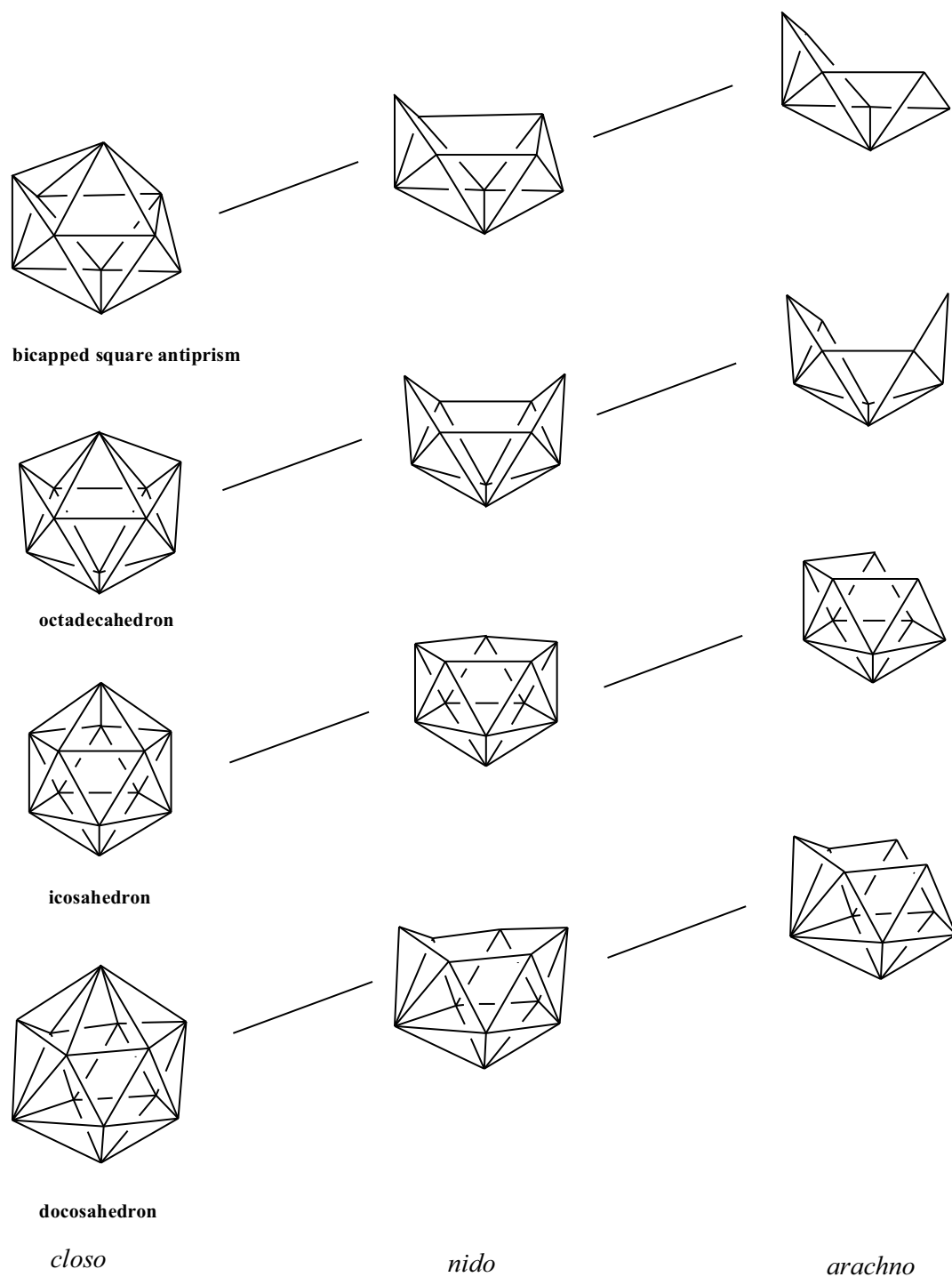


Figure 4 The Wade-Williams-Rudolph Structural Matrix with additional 13- and 14-vertex structures

Boron cages

Closo boron cage structures containing only boron and hydrogen atoms have the general formula $[B_nH_n]^{2-}$. At present, the known boranes have vertices between 5 and 12 and the most stable structure is $[B_{12}H_{12}]^{2-}$ in which the cage contains 12 vertices. It is very difficult to expand a 12-vertex boron cage because it contains a doubly negative charge. In order to expand we should make the cage neutral.

The structure of $[B_{12}H_{12}]^{2-}$ (figure 3) is that of an icosahedron where all the boron atoms occupy a degree-5 vertex. In boranes with more than 12 vertices there are necessarily some degree-6 vertices but the {BH} fragment does not have sufficiently diffuse orbitals for this. Therefore it destabilizes the cage; the vertices that are differing from degree-5 are known as defective. In order to optimise the stability of structures containing more than 12 vertices the defective vertices must be minimised in number and must also be isolated from each other as much as possible^[13].

For boranes the 12-vertex to 13-vertex synthetic barrier has presently not been overcome and so the icosahedral 12-vertex $[B_{12}H_{12}]^{2-}$ ion remains the largest known discrete borane cluster.

Calculations carried out by Schleyer in 1998^[14] on cumulative BH addition energies revealed that 13-vertex, 14-vertex and 15-vertex boranes are thermodynamically unstable with respect to $[B_{12}H_{12}]^{2-}$ (figure 5). The endothermic step from $[B_{12}H_{12}]^{2-}$ to $[B_{13}H_{13}]^{2-}$ is particularly unfavourable; this is because each boron atom is degree-5 in $[B_{12}H_{12}]^{2-}$ whereas in $[B_{13}H_{13}]^{2-}$, as noted above, some of the vertices are degree-6 vertices, which make the cage unstable.

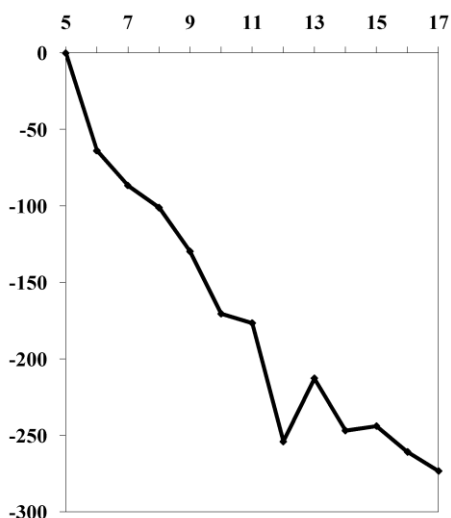


Figure 5 Plot of cumulative BH addition energy (kcal mol⁻¹) vs n for $[B_nH_n]^{2-}$

However formation of larger boranes such as

$[B_{16}H_{16}]^{2-}$ and $[B_{17}H_{17}]^{2-}$ are exothermic processes because some degree 6 vertices are avoided in these species and, indeed, in $[B_{17}H_{17}]^{2-}$ as predicted to be degree 4 vertices, resulting in more stable boranes (figure 6).

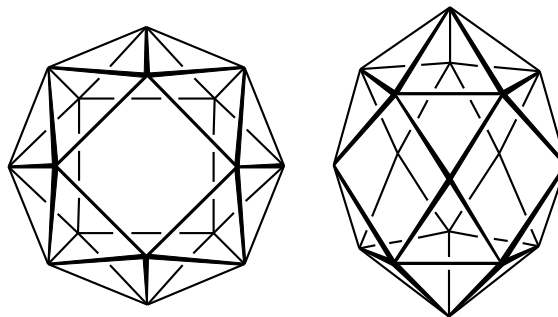


Figure 6 Predicted structures of $[B_{16}H_{16}]^{2-}$ and $[B_{17}H_{17}]^{2-}$

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Fluorescent pH Sensor from Mangosteen Peel

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Acetone extract of mangosteen peel can be used as a fluorescent indicator for the determination of $[H^+]$. The reagent is a relatively inexpensive substance, and the method is user friendly and easy to carry out. It has applications in quantitative analysis and in industry.

Garcinia mangostana (mangosteen) is a tropical fruit found in Asia, and it comes from a tree that grows nearly twenty-three meters in height and takes about ten years to bear fruit. Xanthonoids and Flavanoids are naturally occurring compounds in mangosteen fruit. The mangosteen peel contains a juice that is purple in colour, mainly due to exocarp pigments including xanthonoids. All xanthonoids have a similar core-structure containing several rings and heterocycles (Figure 1), and they can act as chromophores.

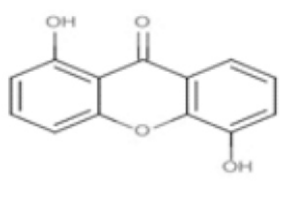


Figure 1: Core structure of xanthonoids.

Hydronium ion can influence the fluorescence of these compounds. H^+ can quench the fluorescence emission of xanthonoids. Therefore the fluorescence emission peak intensity can be utilized to measure $[H^+]$ concentration.

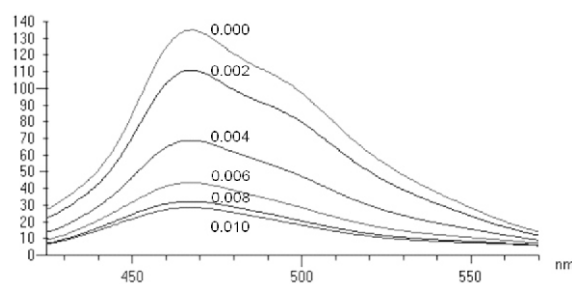


Figure2: Fluorescence spectra as a function of $[H^+]$.

The purple coloured mangosteen peel was separated from the fruit, crushed and extracted with acetone. Thereafter, the extract was concentrated using a rotary evaporator. A series of solutions of varying $[H^+]$ concentration was prepared, and a constant volume of the prepared extract was added to each solution. Fluorescence emission spectra were obtained by exciting each sample at 406 nm, and the fluorescence emission was scanned in the wavelength range of 425

nm to 570 nm. Maximum emission for each sample was observed at 467nm. UV-Visible absorbance was measured for each sample at 406 nm.

Fluorescence quenching can be expressed by the Stern Volmer Equation,

$$\frac{\varphi_f^0}{\varphi_f} = 1 + k_q T_0 \cdot [Q]$$

Where φ_f^0 is the intensity or rate of fluorescence without a quencher, I_f is the intensity or rate of fluorescence with a quencher, k_q is the quenching coefficient in the excited state, T_0 is the lifetime of the emissive excited state without a quencher present and $[Q]$ is the concentration of the quencher. The linearity of the plot $\frac{\varphi_f^0}{\varphi_f}$ vs $[H^+]$ indicates that $[H^+]$ is proportional to the fluorescence emission intensity.

Table 1: Emission data with respect to $[H^+]$.

	concentration of $H^+ / \text{mol dm}^{-3}$	corrected quantum yield
1	0	1.000
2	0.002	1.567
3	0.004	2.288
4	0.006	3.176
5	0.008	3.987
6	0.010	4.719

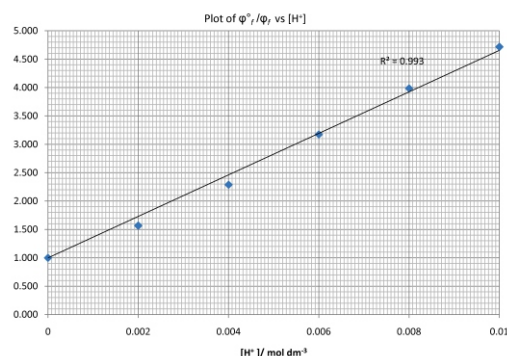


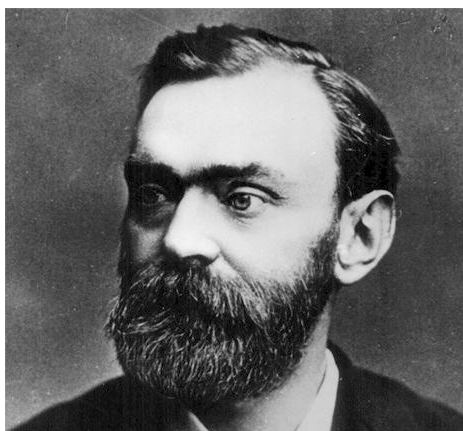
Figure3: Stern-Volmer Plot

Formation of a precipitate during addition of H^+ could be overcome by adding a constant volume of acetone to each sample. Therefore $[H^+]$ can be determined quantitatively with this low cost indicator, and this has the added advantage of being an eco-friendly non-toxic substance extracted from refuse plant material.

From Explosives to Science and Harmony

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Alfred Nobel

The discoverer of dynamite, a Swedish industrialist, chemist, and inventor before his death wrote his last will specifying that the bulk of his fortune should be used for outstanding achievements in the fields of physics, chemistry, medicine, literature and peace. This was Alfred Nobel, who died on December 10, 1896 and thus was the birth of the Nobel Prize.

Alfred Nobel was born on October 21, 1833 in Stockholm, Sweden. His father **Immanuel Nobel** owned a construction company in Stockholm. The year that Alfred was born, Immanuel's construction company became bankrupt. After a stint in Finland, Immanuel moved to St. Petersburg, Russia. He soon became successful in his industrial and business ventures. One of his lucrative business ventures involved manufacturing defense weapons to the Russian government. In 1842, when Alfred was nine years old, Immanuel brought his family to St. Petersburg. In St. Petersburg, Alfred and his brothers were given a first class education by private teachers. Afterwards, Alfred travelled to numerous countries to broaden his horizons and obtain a training in Chemical Engineering. In Paris, the city he liked the most, he worked under the famous chemist, Professor T. J. Pelouze. In Pelouze's lab Alfred met Ascanio Sobrero, the Italian chemist who invented the highly explosive liquid, nitroglycerine. Nitroglycerine is produced by mixing glycerine with sulfuric and nitric acid and is considered too dangerous to be of any practical use. In 1852 Alfred went back to St. Petersburg and commenced work with his father. There, in addition to their construction work, they also performed

experiments to develop nitroglycerine as a commercially and technically useful explosive so that it could be used to blast rocks in connection with their construction work. However, in 1859 Immanuel was again forced into bankruptcy in conjunction with the ending of the war and he left St. Petersburg along with Alfred and his youngest brother and returned to Stockholm. Alfred's other two brothers remained in St. Petersburg and went on to develop the oil industry in the southern part of Russia. They were very successful and became some of the wealthiest persons in that part of the world at that time.

After his return to Sweden in 1863, Alfred Nobel concentrated on developing nitroglycerine as an explosive. His experiments led to several explosions and in one such explosion his youngest brother and several other persons were killed. This did not deter Alfred's work with nitroglycerine. However, he avoided further experiments with nitroglycerine within the Stockholm city limits and moved his work to a barge anchored on Lake Mälaren. Alfred experimented with different additives, which could make handling of nitroglycerine safe and soon found out that mixing nitroglycerine with silica would turn the liquid into a malleable paste. One advantage of this over nitroglycerin was that it could be shaped into rods of different sizes and forms suitable for insertion into drilling holes used for mining.

In 1867 he patented this material under the name of dynamite. To be able to detonate the dynamite rods he also invented a detonator (blasting cap), which could be ignited by lighting a fuse. The market for dynamite and detonating caps grew at a rapid pace. Alfred Nobel not only exported his product to various countries in Europe, America and Australia, but also put up factories in many parts of the world. Alfred Nobel despite being a very skillful entrepreneur and businessman, was a quiet man who had very few friends and never got married. By the time he died on December 10, 1896 after suffering a cerebral hemorrhage, Alfred Nobel had contributed so much to Science as evident by the fact that he possessed a massive three hundred and fifty five patents.

Although Alfred recognized the destructive power of dynamite, he believed it could also bring about peace. He said that "the day when two army

corps can annihilate each other in one second, all civilized nations, it is to be hoped, will recoil from war and discharge their troops". During his lifetime, Alfred Nobel could only witness the destruction his invention could bring about. It is only after his death that his executors found out that he had secretly written in his will that his fortune should be divided into five and used as awards for the greatest benefit on

mankind. The first Nobel Prize was awarded in 1901 and it has been rewarding exceptional people in the above mentioned fields from all corners of the world ever since.

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Recent advances in the world of surfactants

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Surfactants are specific class of chemicals that can significantly decrease the surface tension of two materials (liquid- liquid, liquid-solid, liquid-gas, etc...). These compounds are amphiphilic, structure consist with both hydrophilic element and hydrophobic component (Figure 1).

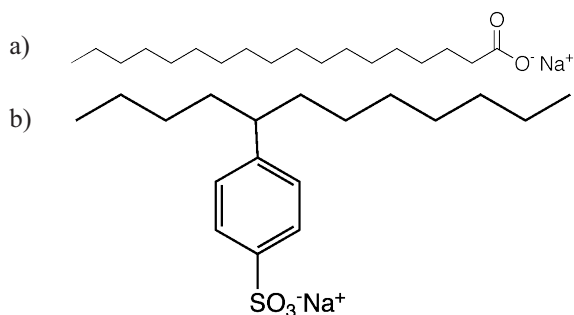


Figure 1. Examples for surfactants: (a) Sodium stearate (b) 4-(5-Dodecyl) benzenesulfonate

In general, hydrophobic component is a hydrocarbon (aliphatic, aromatic or both) consisting 8-18 carbon atom. General anionic hydrophilic components are carboxylates, sulphates, sulphonates and phosphates while amine products are the common cationic hydrophiles. Polyethylene glycol is an excellent example for nonionic surfactant where the ether oxygen of the chain can correlate with water molecules.

The function of the Surfactants is to disperse aqueous droplets in nonpolar solvents or *vice versa* and thus improve the stability while decreasing the heat and mass transportation (Figure 2). Their applications vary from day-to-day cleaning to various industrial processes such as pharmaceutical to enhanced oil recovery. In detail, they have been using in pharmaceutical industry for hosting of polymeric, organic, and enzymatic reactions, refolding of

proteins, separation of biomolecules. Mesoporous and nanosized Surfactant have been merged in to the industries of semiconductor nanocrystals, ceramics, polymers, and polymer-ceramic composites.

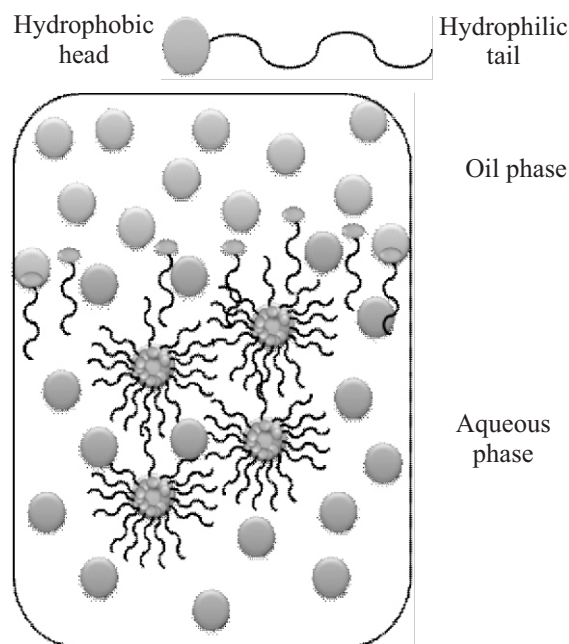


Figure 2. Function of a surfactant

The "forward reaction" of the surfactant process is a well favored rapid process. However, the subsequent recovery or "back reaction" of surfactant is often complicated and unsatisfactory. Recovering/ removal of the surfactant are of great significant mainly in Industrial applications attributable to several factors. Examples are in wastewater treatments where the surfactant activity must be reduce/remove completely before releasing to the environment, in green chemistry where the biodegradability of the surfactant or reduction to harmless products, in biomedical drug delivery where the surfactant should

remove completely after the treatment, in synthesis processors where the purity of the end product is necessary. Common surfactant removal techniques used in the industry are centrifugation, calcination, solvent washing steps, heating, mechanical agitation, and chemical interfacial modification. Three identified main drawbacks encountered with these treatments are extremely high cost, contaminations and large quantities of contaminated aqueous wastes.

Significant advances have been made in the surfactant industry to address those shortcomings over the past decade. Such a remarkable introduction is the “smart surfactant”; ability of the surfactants to react in a specific way on external stimuli such as light, heat, pH, ionic strength, electric field and solvent composition. Smart surfactants undergo chemical or physical structural change that transform and/or loss of the surface activity upon exposure to external stimuli.

“Cleavable” or “destructive” surfactants are one of the novel attractive areas of study in the field of *Smart Surfactants*. Introduction of a labile linkage into surfactant molecules is the using strategy here where the surfactant cleaves into small, easily removed fragments while losing its surfactant activity by separating their hydrophilic and hydrophobic units (Figure 3). Temperature, UV radiation, solvent composition, Ozone and pH are the frequent triggers that have been reported in literature to turn off the surfactant activity. Once the surfactant decomposes by the external stimuli, it is incapable of reforming.

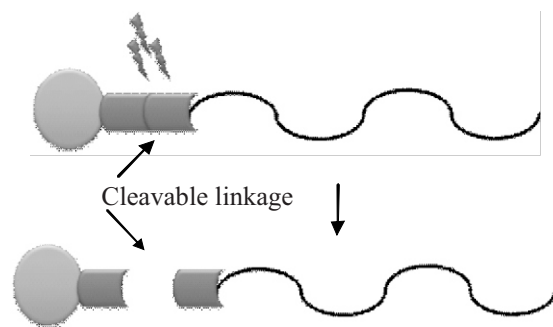


Figure 3. Cleavable surfactant turning into non-surfactant molecules by external stimuli

Several types of cleavable surfactants have been reported and listed below are some of their remarkable discoveries.

1. Thermo-responsive surfactants

Surfactants that destroy or deactivated by thermal trigger are categorized under Thermo-

responsive surfactants. Examples consist with amine oxide surfactants which could decompose at high temperatures, thermally cleavable Diels-Alder adduct as the chemical weak link within the surfactant molecular structure, Piperylene Sulfone moiety that undergoes reversible retro-cheletropic scission of piperylene sulfone.

2. pH sensitive surfactants

pH sensitive surfactant encloses functional groups that are susceptible to base or acid hydrolysis. They decompose into non-surfactant fragments with the introduction of acids or base. Earliest report of pH sensitive surfactant is by Distler who patented a vinyl sulfonate that turns in to non-surfactant product under basic conditions. Cationic surfactants such that derived from bromopropionaldehyde, alkylglucosides, ortho esters, cyclic acetal, ortho bonds, Quaternary Hydrazinium and both cyclic and noncyclic ketals are cleavable with the introduction of acids while alkaline-degradable surfactants generally have a cleavable ester or Si-O bond.

3. Solvent sensitive surfactants

They could be triggered by polar solvent, for instance ethanol, butanol, ethyl acetate, 2-propanol, and Glycerol. Ionic liquids have reported as “smart” solvents that they could change from polar to non-polar state while facilitating the separation of the surfactants.

4. Ozone-Cleavable Gemini Surfactants

Surfactants containing carbon-carbon double bonds as the connecting part of hydrophobic and hydrophilic entities could be easily converted to deactivate fragments with the exposure of ozone environment.

5. Photoresponsive surfactants

Surfactants equipped with UV sensitive components, such as alkylaryl ketone sulfonates and diazosulfonates that decompose or resulting in changes in surface-active behavior upon irradiation entitles as Photoresponsive surfactants. Thiirane Oxide, Noctylthiirane oxide surfactants has been reported in the literature.

Cleavable surfactants are the latest addition to the world of surfactants. Without doubt they are of great use in many aspects!

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“Smart” Polymers

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“Smart” polymers are special type of polymers that can undergo changes in their properties such as solubility, shape, and surface characteristics due to small external changes in the environment such as temperature, pH, light, electric and magnetic field, ionic strength, and chemical and biological agents.¹ These are also known as “stimuli-responsive polymers”, “environmental-sensitive polymers” or “intelligent polymers”. Environmental stimuli can be classified into three categories, physical, chemical, and biochemical.^{1,2} Temperature, light, electromagnetic radiation, electric and magnetic field, pressure, sound, and mechanical stress-strain are examples for physical stimuli. Ionic strength of the medium, pH, and chemical agents belong to chemical stimuli. Enzyme substrates and affinity ligands are examples for biochemical stimuli.^{1,2} Smart polymers can be in different physical forms such as micelles, permanently cross-linked hydrogels, reversible hydrogels, dendrimers, nanocomposites.¹⁻¹⁰

Thermo-Sensitive Polymers

Thermo-sensitive polymers are characterized by the lower critical solution temperature (LCST). LCST is the temperature at which a polymer solution undergoes phase transition from a soluble to insoluble state.^{11,12} It is the lowest temperature of the phase separation curve on a concentration-temperature diagram.¹¹ In other words the thermo-sensitive polymers become hydrophobic and undergoes coil-to-globule transition upon increasing the surrounding temperature above their LCST (Figure 1). A few examples of thermo-sensitive polymers and their LCSTs are given in Figure 2.

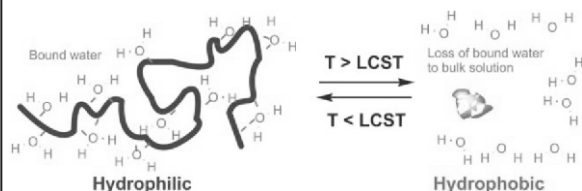


Figure 1. Behavior of thermo-sensitive polymers above and below its LCST¹²

pH-Sensitive Polymers

Polymers which respond to changes in acidity are known as pH-sensitive smart polymers. These

polymers also undergo coil-to-globule transition when the pH is varied.^{1,13} pH sensitive polymers can be further categorized as cationic or anionic. Polyacids, such as poly(acrylic acid) (PAAc) and poly(methacrylic acid) (PMAAc) are a few examples of anionic pH-sensitive polymers.¹³⁻¹⁵ Polybases, such as poly(*N,N*-dimethyl aminoethyl methacrylate) (PDMAEMA) and poly(4-vinyl pyridine) (PVP) are a few examples of pH-sensitive cationic polymers.¹³⁻¹⁵ Polyacids are ionizable (and thus are expanded) at higher pH values, while polybases ionize at low pH.

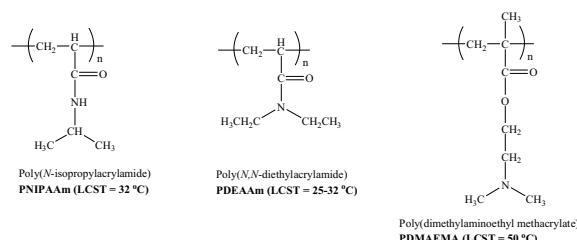


Figure 2. Examples of thermo-sensitive polymers¹²

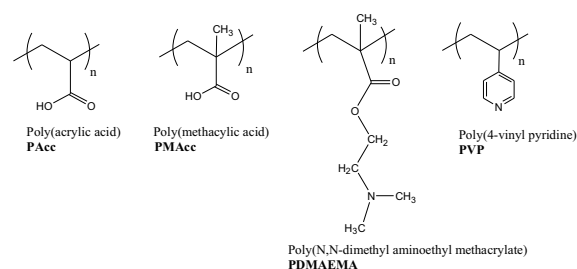


Figure 3. Examples of pH-sensitive polymers¹³⁻¹⁵

Photo-Sensitive Polymers

Photo-sensitive polymers contain light sensitive chromospheres that can undergo chemical and physical changes when exposed to light.^{1,17-19} They can be categorized as photo-responsive polymers (polymers that change in molecular shape), photochromic polymers (polymers that undergo reversible color change) and photo reactive polymers (polymers that change in its constitutions).

Electric and Magnetic Field-Sensitive Polymers

Polymers that exhibit swelling, shrinking, or bending in response to an electric and magnetic field are known as electric and magnetic field sensitive polymers, respectively.²²⁻²⁴ Conducting polymers such as sulphonated-polystyrene (PSS) and polythiophene (PT) are examples of electrically responsive

polymers.^{25,26}

Enzyme-Sensitive Polymers

Enzymes are now becoming a promising stimulus that can be used in smart polymer synthesis. Enzymes such as azoreductase and glycosidases can decompose chitosan, polysaccharides, cyclodextrin and dextrin. Therefore polymers synthesized from these can be destroyed using enzymes. These polymers are useful as colon-specific drug delivery systems. The advantages of enzyme-responsive smart polymers include high selectivity and efficiency, and they work for specific substrates under mild conditions.²⁷⁻³⁰

Multi-Sensitive Polymers

Combination of several responsive moieties within one polymer results smart polymers exhibiting complex responsive behavior. Since these polymers respond to multiple stimuli, they have more possible uses. The most common multi-sensitive polymers are dual-sensitive smart polymers with both thermo and pH sensitivity.^{3,31-38} An amphiphilic block copolymer poly(2-dimethylamino)ethyl methacrylate-*b*-poly(2-nireobenzyl acrylate) which is sensitive to pH, temperature, CO₂ and UV light was synthesized by Wang and co-workers.³⁴ Wenceslau et al recently reported synthesis of dual temperature and pH-sensitive interpenetrating polymer network hydrogels.³⁶

Applications of Smart Polymers

Smart polymers have wide range of applications in biomedical field, food and textile industries.^{5,11,13,14,18,21-24,31,32,34,39,40,41} They use as sensors and catalysts as well.⁴²⁻⁴⁶ Biomedical applications of smart polymers include drug and gene delivery, bioseparation, immobilized biocatalysts, immunoassays, and biomimetic actuators.

Smart polymers for drug and gene delivery

Properties of smart polymers can be used for the control release of a drug at a specific target of the body and/or at a specific time. Polymers sensitive to single stimulus or multi stimuli have been widely examined as drug and gene delivery system.^{4,5,18,21-24,31,32,34,39} For example a drug can be incorporated into a pH sensitive polymeric hydrogel that releases the drug contents in to the blood stream (at pH 7.4) instead of releasing at the stomach. These drugs were developed by considering the pH difference at stomach (pH 2) and colon (pH 10). Simple drug formulation and administration

procedures, ability to deliver both hydrophilic and hydrophobic drugs, and less systemic toxicity are other advantages of this type of drug release systems. Mesoporous silica nanospheres was modified by Li and co-workers with both pH- and electric field-sensitive polymers to obtain a novel dual-mode drug delivery system.³² Chen et al. recently reported incorporation of anticancer drug, doxorubicin (Dox) into dual pH and temperature sensitive micelles. Change in both pH and the body temperature cause the drug to release from the micelles. According to *in vivo* studies Dox-loaded dual sensitive micelles showed a high rate of anticancer drug in cancer cells and excellent antitumor activity against several cancer cells.³⁷ Clejo and co-workers reported synthesis of thermo-sensitive cationic block copolymer nanocarriers for gene delivery. The *in vitro studies* polymer-DNA complexes showed high efficiency for transfection of HeLa cells.³⁹

Smart polymers as sensors

Advantages of smart polymers as sensors include tunable detection sensitivity, aqueous dispersibility, structural stability and easy incorporation into devices, as compared to their small molecule analogues. Sensors can be synthesized by covalently incorporating environmentally sensitive fluorescent molecule to any polymer with different responsive polymer. When the polymer responses to either temperature or pH change it can either collapse or expand. This affects to the fluorescent signal intensities (Signals can be either increased or decreased). These polymers can be used to detect temperature, pH and metal ions (Cu²⁺, Hg²⁺, K⁺) and other molecules.⁴² Smart polymers are also used for fabrication of glucose sensors and controlled insulin releasing systems.^{43,44}

Smart polymers for catalysis

One of the novel applications of smart polymers is their application in catalysis.⁴⁵⁻⁴⁷ For example Elbert *et al* has recently used redox-responsive polyvinylferrocene-grafted silica nanoparticles to control the catalytic activity of Grubbs second generation catalysts which are attached to the exterior of the nanoparticle for the ring-opening metathesis polymerization of norbornene monomer.⁴⁵

Smart polymers for bioseparation

Novel stationary phases have been developed using smart polymers for size exclusion, ion exchange,

affinity and hydrophilic-hydrophobic interaction based separation of biomolecules. PNIPAAm grafted silica beads, polystyrene beads and glass beads have been developed as column packing materials for size exclusion chromatography.⁴⁸⁻⁵⁰ Size of the pores can be easily changed by changing the temperature. Therefore biomolecules with different molecular weights can be easily separated. Anionic and cationic ion exchange column materials have been synthesized using different pH sensitive polymers.^{51,52} The affinity based bioseparation involves bioconjugation of biomolecules (sugars, oligonucleotides, proteins, lipids, ligands) to responsive polymers.^{53,54} When those biomolecules are conjugated to temperature sensitive polymer, solubility behavior of the biomolecule can be easily altered by heating or cooling the polymer above or below its LCST. Similarly HPLC column packing materials for hydrophilic-hydrophobic interaction based separation have been obtained by attaching thermo-sensitive polymers to silica.^{55,56} These types of stationary phases provide additional benefits where selective separations can be done based on temperature gradient as well.

Smart surfaces and coating

Smart surfaces can be obtained by grafting or immobilizing stimuli-responsive polymers into different surfaces. Properties of a surface (wettability, permeability, mechanical, adhesive, and adsorptive) can be changed when the smart polymer is introduced into a surface. There are coatings that are capable of rapid release of chemicals and also which can undergo self-healing.⁵⁷⁻⁶⁰ Li et al reported the synthesis of silica nanotubes with a pH, temperature and redox-sensitive polymeric outer wall that can be used as self-healing coatings for metal corrosion protection.⁵⁸ Different light-sensitive surface coatings had been synthesized by immobilizing light-sensitive molecules such as azobenzene, salicylideneaniline and spiropyran on glass, polycarbonate and steel surfaces.⁶⁰

Smart or stimuli-responsive polymers are one of the promising fields in polymer science. These polymers have become a useful class of polymers due to their wide range of applications as described here. However there are challenges that have to be addressed in this field.^{61,62} Synthesis of biocompatible, biodegradable and non-toxic smart polymers for biomedical applications is one of the major challenges. Synthesis of multi-responsive smart polymers is more advantageous since those polymers can have wide range of applications.

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Why Study Natural Products?

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A natural product is a chemical compound produced by a living organism – found in nature that usually has a pharmacological or biological activity for use in pharmaceutical drug discovery and drug design.

Natural products may be extracted from tissues of terrestrial plants, marine organisms or micro-organism fermentation broths. A crude (untreated) extract from any one of these sources typically contains novel, structurally diverse chemical compounds, which the natural environment is a rich source of.

Chemical diversity in nature is based on biological and geographical diversity, so researchers travel around the world obtaining samples to analyze and evaluate in drug discovery screens or bioassays. This effort to search for natural products is known as bioprospecting.

Natural Products are small molecules and provide the source of inspiration for drug discovery. In particular, these compounds are important in the treatment of life-threatening conditions.

A course on Natural Products Chemistry is taught as an optional topic at the College of Chemical Sciences, the Institute of Chemistry as a part of its Graduateship in Chemistry programme. But, surprisingly not many students opt to take this course. This is rather surprising when one considers that a sound knowledge of natural products chemistry is vital to everyone, especially for those specialising in chemistry.

I have given below the natural products from a fruit that is popular in Sri Lanka and its medicinal properties to show that knowledge in this chemistry topic is important to every one: The fruit is called **soursop** (Figure 1) and is botanically described as *Annona muricata* of the plant family **Annonaceae**. In sinhala it is called **Katu Aatha** or **Anoda**.

I am sure that everyone will know the fruit (Figure 1) that is sold in many parts of Sri Lanka. But many do not eat it as they do not like the smell of it.



Figure 1: Soursop

The fruit contains many vitamins including vitamin C and several B vitamins such as thiamin, riboflavin and niacin, along with calcium, phosphorus and a small amount of iron. The high concentration of vitamin C in the fruit is beneficial in dealing with the common cold and flu, cough and blocked nose. The riboflavin in the fruits aids in the prevention of migraines. The fruit is also a good source of the amino acid called tryptophan, which encourages sleepiness as well as relaxation. The iron that is present in the prickly fruit helps in the prevention of a common blood disorder known as anemia, which is where the blood lacks sufficient healthy red blood cells.

In the recent past, the fruit was highlighted in the global media as a cancer fighting fruit as it was found to be 1,000 times more effective than chemotherapy. The fruit consists of acetogenins, which inhibits the development of damaged cells just before they could become cancerous.

Acetogenins are a class of polyketide natural products found in plants of the family Annonaceae. They are characterized by linear 32- or 34-carbon chains containing oxygenated functional groups including hydroxyls, ketones, epoxides, tetrahydrofurans and tetrahydropyrans. They are often terminated with a lactone or butenolide. Over 400 members of this family of compounds have been isolated from 51 different species of plants. Examples include: **Annonacin** (Figure 2).

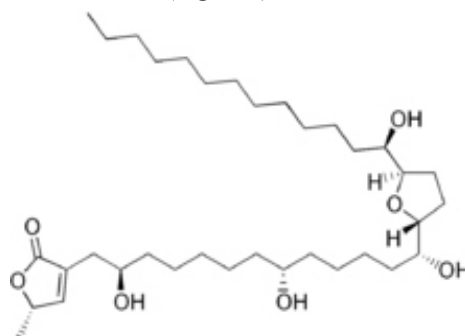


Figure 2: Structure of Annonacin.

The fruit has been found to be especially beneficially effective in preventing breast cancer. Besides its cancer fighting properties, the fruit is also known to be effective against internal parasites and

worms. It is also known to lower high blood pressure and is used to treat depression, stress and nervous disorders.

But, the compound **annonacin**, which is contained in the seeds of soursop, is a neurotoxin associated with neurodegenerative disease.

So what do we do? Eat the fruit or forget about the fruit?

You should realise that too much of anything is bad for us. Can you take 5 teaspoons full of sugar in your cup of tea because you want a sweet cup of tea? You will end up a diabetic for life soon if you continue to do so during your child/adult life.

Organometallic Chemistry– Part 2

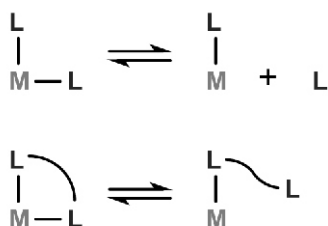
by

Dr Buddhie S. Lankage

Some Important Ligand Nomenclature

The properties of organometallic compounds of transition metals are dependent on the nature of coordinated ligands.

1. Chelate Effect: The chelate effect or chelation is one of the most important ligand effects in transition metal coordination chemistry. Since most metal-ligand bonds are relatively weak compared to C-C bonds, M-L bonds can often be broken rather easily, leading to dissociation of the ligand from the metal. Consider the two examples shown below:



The second metal complex is much less likely to lose one of the ligands due to the bridging group that holds the ligands in proximity to the metal center. From a kinetic viewpoint, if one of the ligands dissociates, it will remain close enough to the metal center to have a high probability of re-coordinating before another ligand can get in and bind. From a thermodynamic viewpoint, by tethering two donor ligands together, one removes the entropic driving force for dissociating a ligand and thus making more particles in solution (more disorder).

The chelate effect can be extremely significant. There are cases known where the presence of a chelate will change the equilibrium constant by a factor of 10 favoring the coordinated form of the ligand to the metal over the dissociated form. *Naturally, the longer (length of the chelating ligand) and more flexible the bridging group in a chelating ligand, the less significant the chelating effect.* It is possible to design

ligands with sterically enforced chelates.

2. Hapticity: η^x “eta- x ” was originally developed to indicate how many carbons of a π -system were coordinated to a metal center. Hapticity is another word used to describe the bonding mode of a ligand to a metal center. An η^5 -cyclopentadienyl ligand (Cp), for example, has all five carbons of the ring bonding to the transition metal center.

η^x values for carbon ligands where the x value is odd usually indicate anionic carbon ligands (e.g., η^5 -Cp, η^1 -CH₃, η^1 -allyl or η^3 -allyl, η^1 -CH=CH₂). The number of electrons donated (ionic method of electron counting) by the ligand is usually equal to $x+1$. Even η^x values usually indicate neutral carbon π -system ligands (e.g., η^6 -C₆H₆, η^2 -CH₂=CH₂, η^4 -butadiene, η^4 -cyclooctadiene). The number of electrons donated by the ligand in the even (neutral) case is usually just equal to x .

η^5 -Cp 5Cs	η^3 -Cp 3Cs	η^3 -allyl 3Cs	η^1 -allyl 1C

However, the questions were raised in the case of a non-carbon ligands as to the bonding mode (or hapticity) of the ligand donor atoms to the metal. For example, the bisphosphine Ph₂PCH₂CH₂PPh₂ [dppe=1,2-bis(diphenylphosphino)ethane] is normally a chelating ligand, but there are metal complexes known where only one of the phosphine atoms is coordinated to the metal center and the other is “dangling.”

3. Bridging: μ^x “mu- x ” is the nomenclature used to indicate the presence of a bridging ligand between two or more metal centers. The x refers to the number of

metal centers being bridged by the ligand. Usually most authors omit $x=2$ and just use μ to indicate that the ligand is bridging the simplest case of two metals. There are three different general classes of bridging ligands:

- Single atom bridges
- Two donor atoms separated by a bridging group (typically organic)
- Two donor atoms directly bonding to one another

Nomenclature

1. Cp (cyclopentadienyl) ligands, usually comes first, followed by the metal center, e.g. $[\text{Cp}_2\text{TiCl}_2]$
2. Other anionic multi-electron donating ligands are also often listed in front of the metal, e.g., trispyrazolylborate anion (Tp)
3. In formulas with hydride ligands, the hydride is sometimes listed first. Rules 1 and 2, however, take precedence over this rule: $[\text{HRh}(\text{CO})(\text{PPh}_3)_2]$ and $[\text{Cp}_2\text{TiH}_2]$
4. Bridging ligands are usually placed next to the metals and then followed by the other ligands (note that rules 1 and 2 take precedence): $[\text{Co}_2(\mu\text{-CO})_2(\text{CO})_6]$, $[\text{Rh}_2(\mu\text{-Cl})_2(\text{CO})_4]$ and $[\text{Cp}_2\text{Fe}_2(\mu\text{-CO})_2(\text{CO})_2]$
5. Anionic ligands are often listed before neutral ligands: $[\text{RhCl}(\text{PPh}_3)_3]$, $[\text{CpRuCl}(\text{=CHCO}_2\text{Et})(\text{PPh}_3)]$ (neutral carbene ligand) and $[\text{PtIme}_2(\text{C}\equiv\text{CR})(\text{bipy})]$

Valence Electron Count and 18 Electron Rule

Electron counting is the process of determining the number of valence electrons about a metal center in a given transition metal complex. To determine the electron count for a metal complex:

1. Determine the oxidation state of the transition metal center(s) and the metal centers resulting d -electron count. To do this one must:

- note any overall charge on the metal complex
- know the charges of the ligands bound to the metal center (ionic ligand or neutral ligand method)
- know the number of electrons being donated to the metal center from each ligand (ionic ligand or neutral ligand method)

2. Add up the electron counts for the metal center and ligands

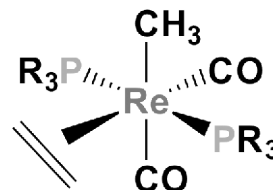
Complexes with 18e⁻ counts are referred to as saturated, because there are no empty low-lying orbitals to which another incoming ligand can coordinate. Complexes with counts lower than 18e-

are called unsaturated and can electronically bind additional ligands.

The vast majority of stable diamagnetic organometallic compounds have 16 or 18 valence electrons due to the presence of the five d orbitals which can hold 10 more electrons relative to C, O, N, etc.

Examples: Determine the number of valence electrons (NVE)

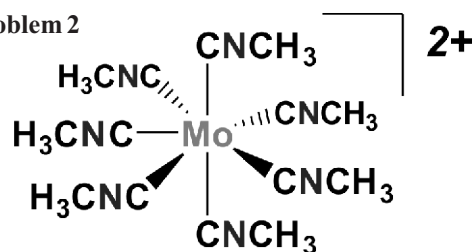
Problem 1



1. There is no overall charge on the complex (it is neutral)
2. There is one anionic ligand (CH_3^- , methyl group)
3. Since there is no overall charge on the complex and have one anionic ligand present, the Re metal atom must have a +1 charge to compensate for the one negatively charged ligand. The +1 charge on the metal is also its oxidation state. Therefore, the Re oxidation state is +1.

Ionic method		Neutral method	
Re(+1)	= d^6	Re(0)	= d^7
2 PR_3	= 4e-	2 PR_3	= 4e-
2 CO	= 4e-	2 CO	= 4e-
CH_3^-	= 2 e-	CH_3	= 1e-
$\text{CH}_2=\text{CH}_2$	= 2e-	$\text{CH}_2=\text{CH}_2$	= 2e-
Total	= 18e-	Total	= 18e-

Problem 2



1. There is a +2 charge on the complex
2. The CNCH_3 (methyl isocyanide) ligand is neutral, but let's check the Lewis Dot structure to make sure that is correct: $\text{:C}\equiv\text{NCH}_3$
3. Because there is a +2 charge on the complex and there are all neutral ligands present, the Mo has a

+2 charge and oxidation state.

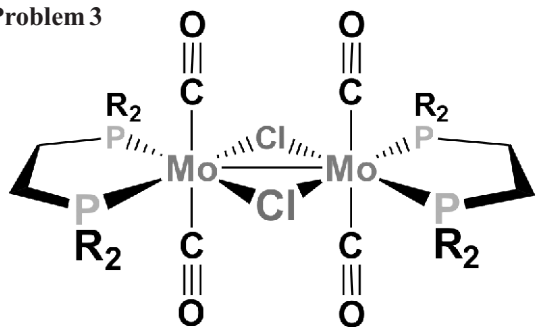
Ionic method

Mo(+2) = d^4
 7 CNCH₃ = 14e⁻
 Total = 18e⁻

Neutral method

Mo(0) = d^6
 7 CNCH₃ = 14e⁻
 Charge (+2) = -2
 Total = 18e⁻

Problem 3



Metal-metal (M-M) bond is a simple covalent bond with each metal contributing 1e⁻ to the bond. Most M-M bonded complexes are symmetrical, but if the metals are different, however, one does need to figure out each metal center.

The simple rule for M-M bonding is that if there are two metal atoms next to one another and each has an odd electron-count, pair the odd electrons to make a M-M bond. This is electron-counted as a 1e⁻

donation from one metal to the other.

This example also has μ -Cl ligands. Bridging ligands with at least 2 lone pairs almost always donate 2e⁻ to each metal center.

Oxidation state determination: There are a total of two anionic ligands for two metal centers (overall complex is neutral). Thus each metal center needs to have a +1 oxidation state to balance the anionic ligands.

Very Common Mistake: Students determining the oxidation state for complexes with 2 or more metal centers often add up all the anionic ligands and then figure out the oxidation state for only one of the metal centers based on this. Students need to take into account the charge (if any) on the complex and divide up the anionic ligand charges between all the metal centers present. Each metal in the complex shown above is in the +1 oxidation state NOT +2.

Ionic method

2 Mo(+1) = d^1
 4 PR₃ = 8e⁻
 4 CO = 8e⁻
 2 μ -Cl = 8e⁻
 Mo-Mo = 2e⁻
 Total = 36e⁻
 per Mo = 18e⁻

Neutral method

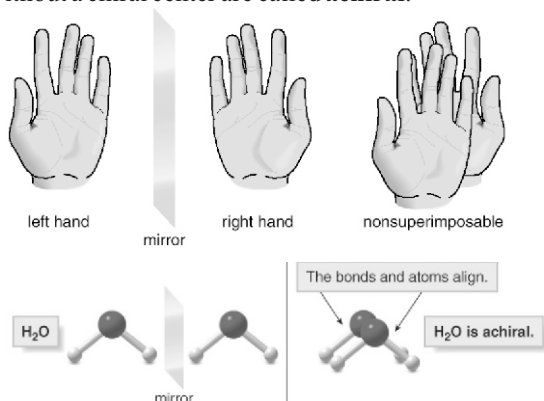
2 Mo(0) = d^1
 2 PR₃ = 8e⁻
 2 CO = 8e⁻
 2 μ -Cl = 6e⁻
 Mo-Mo = 2e⁻
 Total = 36e⁻
 per Mo = 18e⁻

Stereochemistry and Chirality

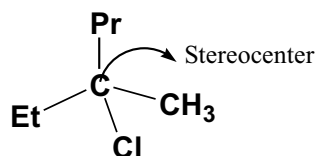
by

Dr. T Gobika

Stereochemistry is the chemistry that studies the properties of stereoisomers. Chirality is an important factor in the stereochemistry. The molecules or objects which are non superimposable with the mirror images are called **chiral** and the molecules or objects without a chiral center are called **achiral**.



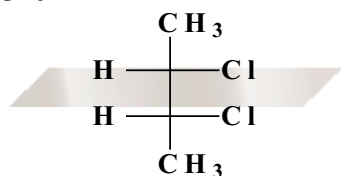
If a tetrahedral carbon attached to four different substituent then that carbon is a “chiral carbon” and the carbon in the center is called “chiral center” or “stereo center” or “stereogenic center”.



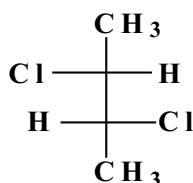
A molecule with one chiral center is always chiral but a molecule with more than one chiral centers is may or may not be chiral. This is depends on whether the given molecule with two or more chiral centers contains a **plane or center of symmetry**.

Plane of symmetry is a mirror plane which bisects an object so that the two halves of the molecule are mirror images of each other. Plane may pass through

the atoms, between the atoms or both (Fisher projections will be discussed later in detail).

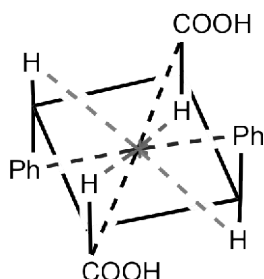


In this Fisher projection, the plane is passing between the atoms therefore this molecule is achiral.



In this Fisher projection no plane or center of symmetry therefore this isomer is chiral.

Center of symmetry is a point within an object such that a straight line drawn from any part or group in the object to the center and extended an equal distance on the other side reaches an identical part of group.

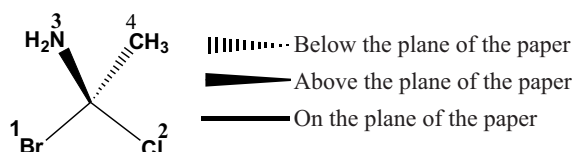


The R and S Convention for Absolute Configuration

R, S method was developed in 1956 by R. S. Cahn, C. Ingold and V. Prelog. R, S convention is also known as CIP convention, is the universally recognized method used to specify absolute configuration at chiral centers in organic molecules. The absolute configuration at a chiral center is designated either R or S. **R** stands for righthanded and **S** stands for lefthanded.

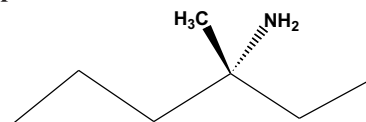
Sequence rule to determine R-S configuration

Step 1. Rank each atom attached to the stereocenter in order of decrease their atomic number. In other words, the atom attached to the stereocenter with the highest atomic number will be ranked first and the atom with the lowest atomic number will be ranked fourth.



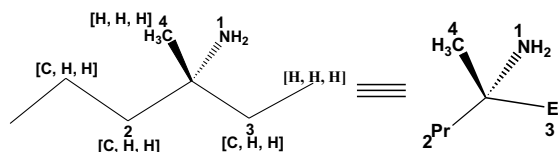
If there are two similar atoms of the substituents directly attached to the stereocenter, then compare the atomic number of the second atom in each substituent and continue on until it reaches the first point of difference.

Example 1



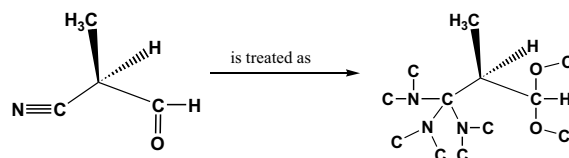
In example 1 three different types of carbon atoms are attached to the stereo center, which are -CH_3 , $\text{-CH}_2\text{CH}_3$ and $\text{-CH}_2\text{CH}_2\text{CH}_3$ groups. Carbon in CH_3 group is attached to three hydrogens [H, H, H] while carbon which attached to the stereocenter in $\text{-CH}_2\text{CH}_3$ group is also attached to a carbon and two hydrogens [C, H, H]. Therefore among these two, $\text{-CH}_2\text{CH}_3$ group will get higher priority since the atomic number of the carbon is higher than the hydrogen.

If we compare $\text{-CH}_2\text{CH}_3$ and $\text{-CH}_2\text{CH}_2\text{CH}_3$ groups, in both substituents the carbon which attached to the stereocenter is also attached to two hydrogens and one carbon. At this stage we cannot determine the priority. Therefore we have to move on to the next atom attached to the first carbon atom. In $\text{-CH}_2\text{CH}_3$ group the second carbon is attached to three hydrogens [H, H, H] while in $\text{-CH}_2\text{CH}_2\text{CH}_3$ group the second carbon is attached to two hydrogens and one carbon atoms [C, H, H] therefore $\text{-CH}_2\text{CH}_2\text{CH}_3$ group will get higher priority over $\text{-CH}_2\text{CH}_3$ group.



If atoms with multiple bonds are attached to the stereocenter then they are considered as equivalent number of similar atoms attached through a single bond.

Example 2

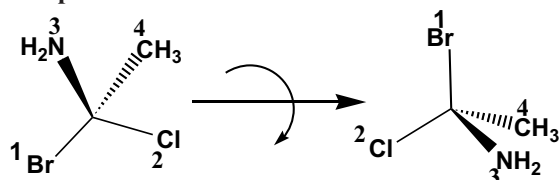


In example 2 carbon in the -CN group is bonded to the stereocenter in which carbon and nitrogen is bonded through a triple bond. Therefore in order to assign the priority we have to consider that carbon is bonded to three nitrogens and nitrogen is bonded to three carbons as they are connected through a triple bond. Similarly, oxygen in the aldehyde group is bonded to the carbon through a double bond therefore we have to consider that oxygen is bonded to two carbons through a single bond and carbon is bonded to two

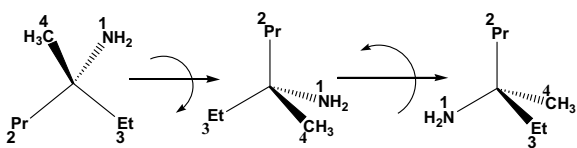
oxygen.

Step 2. View the compound with the lowest priority substituent that is pointing away from you (below the plane).

Example 3



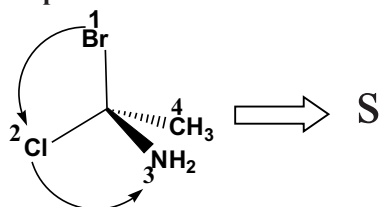
Example 4



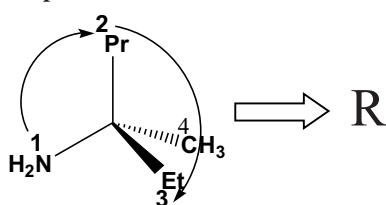
In example 4 the highest priority group, NH_2 is away from you. To make the lowest priority group away from you hold Pr group and rotate other three substituents by 120° in "anticlockwise".

Step 3. Draw a circular arrow by connecting substituents 1 to 3 from highest to lowest priority. If the arrow moves "clockwise" then the stereocenter is R and if the arrow moves "anticlockwise" then the stereocenter is S.

Example 3



Example 4



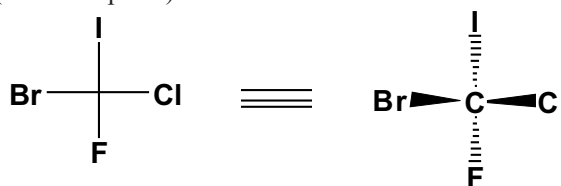
Fisher projections

In the Fisher projection, a tetrahedral carbon atom is represented by two crossed lines which are horizontal and vertical. The purpose of drawing fisher projections is to show configuration of stereo center without drawing wedges and dashes or using model.

How to Assign R, S configurations to Fisher

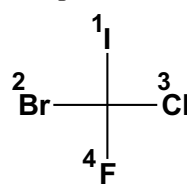
projections

Step 1. Horizontal line will point towards you (above the plane) and the vertical line will point away from you (below the plane).

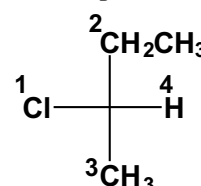


Step 2. Rank the atoms attached to the stereocenter(s) according to their atomic number.

Example 5

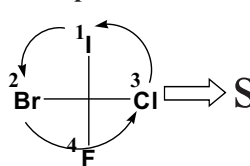


Example 6

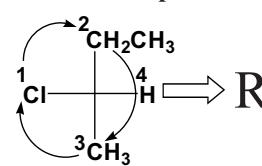


Step 3. Determine the direction of rotation by connecting 1 to 3 and assign R or S.

Example 5

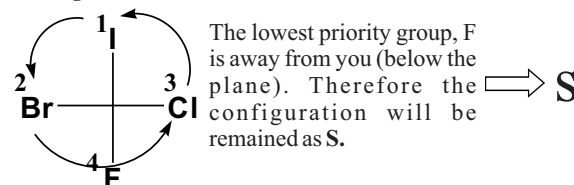


Example 6



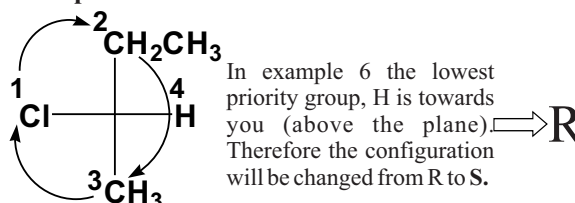
Step 4. The most important factor to consider when assigning R and S is that, the lowest priority substituent should be always away from you (below the plane). If the lowest priority group is away from you then the configuration will be remained as same as mention in 3rd step. On the other hand, if the lowest priority group is towards you (above the plane) then we should rotate the molecule in order to make it away from you (below the plane). Therefore after the rotation the configuration will be opposite to the configuration which was obtained before rotation.

Example 5



The lowest priority group, F is away from you (below the plane). Therefore the configuration will be remained as S.

Example 6



In example 6 the lowest priority group, H is towards you (above the plane). Therefore the configuration will be changed from R to S.

When assigning **R** and **S** configurations to Fisher projections, all four steps should be followed in order to get correct answers.

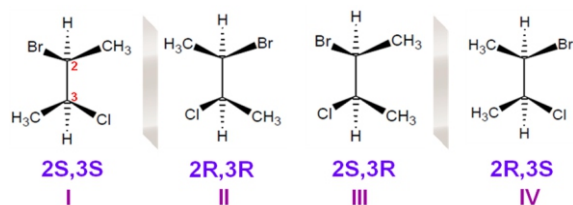
Stereoisomers are compounds made up of the same atoms which are connected by the same sequence of bonds, but having different three dimensional structures. Stereoisomers can be divided in to two groups such as Enantiomers and Diastereomers.

Enantiomers (optical isomer): Stereoisomers that are nonsuperposable mirror images.

Diastereomers: - Stereoisomers that are not enantiomers. In other words, diastereomers are pair of isomers which have opposite configurations at one or more chiral centers but are not mirror images of each other. Diastereomers are possible when a molecule contain minimum of two stereocenters.

In a molecule if there is no symmetry element then there will be 2^n stereoisomers present. Where n is the number of chiral centers.

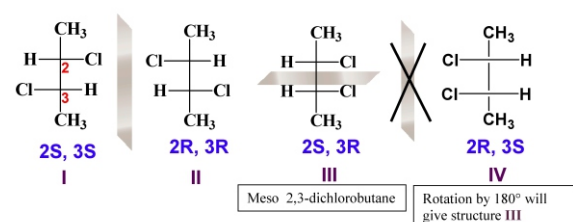
Example 7 :- 2-bromo-3-chlorobutane



In example 7 there are two stereocenters available and therefore not only enantiomers but also diastereomers are possible. **I** and **II** are enantiomers because they are mirror images and they are nonsuperimposable. Similarly **III** and **IV** are enantiomers. **I** is diastereomerically related with **III** and **IV** since only one of the two stereocenters is interchanged. **III** and **IV** are diastereomers of **II**.

If there is atleast one plane or center of symmetry in the molecule then we cannot use 2^n to find the number of stereoisomers.

Example 8: - 2,3-dichlorobutane



Only three stereoisomers are possible for 2,3-dichlorobutane. **I** and **II** are enantiomers. The **III** molecule is called meso molecule which is

diastereomer of **I** and **II**. A meso compound is a molecule that contains more than one stereo centres but that is superimposable on its mirror image. Meso molecules are optically inactive because they are achiral due to the presence of plane of symmetry.

Properties of stereoisomers and the optical activity

Enantiomers will exhibit same physical properties such as melting point, boiling point and solubility in standard solvents but diastereomers can show different physical properties.

Property	A	B	C	A + B (1:1)
melting point (°C)	171	171	146	206
solubility (g/100 mL H ₂ O)	139	139	125	139
[α]	+13	-13	0	0
R,S designation	R,R	S,S	R,S	—
d,l designation	d	l	none	d,l

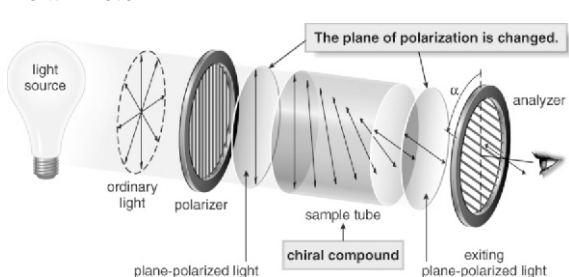
The properties of the stereoisomers of tartaric acid are shown above. **A** and **B** are enantiomers with same melting point and solubility but differ only in the specific rotation.

Specific rotation is a standardized physical constant for the amount that a chiral compound rotates the plane-polarized light. Specific rotation is denoted by the symbol $[\alpha]$ and defined by using a specific sample tube length (l , in dm), concentration (c in g/mL), temperature (25°C) and wavelength (589 nm).

$$\text{Specific rotation} = [\alpha] = \frac{\alpha}{l \times c}$$

With chiral compounds, the plane polarized light is rotated through an angle. The angle is measured in degrees (°), and is called the observed rotation. A compound that rotates polarized light is said to be optically active.

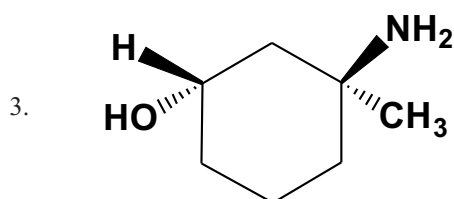
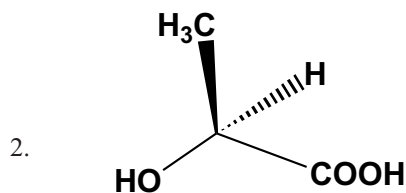
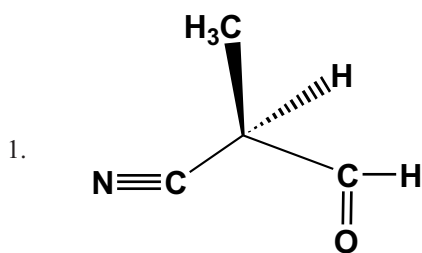
Polarimeter



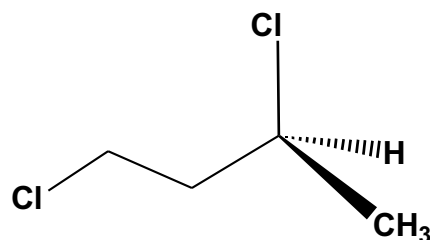
The rotation of plane polarized light can be either clockwise or anticlockwise. If the rotation is clockwise then the compound is called dextrorotatory. The rotation is labeled as *d* or (+). Similarly, if the rotation is anticlockwise then the compound is called levorotatory and the rotation is labeled as *l* or (-). The two enantiomers of tartaric acid, A and B rotate the plane-polarized light to an equal extent (13°) but in opposite directions.

A mixture containing equal quantities of enantiomers is called a racemic mixture. A racemic mixture is optically inactive because the two enantiomers rotate plane-polarized light to an equal extent but in opposite directions therefore the rotations cancel off and therefore no rotation is observed.

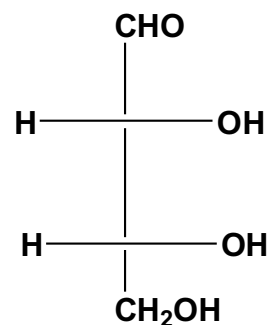
Problem:- Assign R or S configuration to each chirality center in the following molecules?



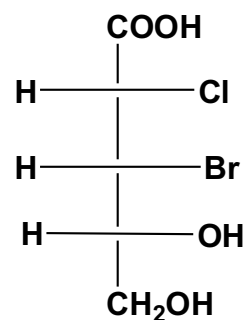
4.



5.



6.



Answers.

1. 2R
2. 2S
3. 1S3S
4. 2S
5. 2R3R
6. 2S3R4R

Graduate Chemists Welfare Fund

This fund has been established with effect from 1-1-2012. The principal benefits towards CCS Graduate Chemists would be,

- a) To provide partial assistance towards international travel of those proceeding abroad for PG degrees (once a life time)
- b) To provide partial assistance towards registration fees in respect of IChemC/CCS events such as International Conferences (Preference for those presenting papers)
- c) To provide assistance towards registration fees for IChemC/CCS training seminars etc.
- d) To provide partial assistance towards activities of the Alumni Association.

Note: Depending on the demand, Graduate Chemists who maintain positive content and participate in IChemC/Alumni activities will get preference for the above mentioned benefits.

43rd Annual Sessions of the Institute of Chemistry Ceylon 2014

Theme:

Curricula and Evaluation in Chemistry for a Sustainable Economy

Date: June, 2014

CALL FOR ABSTRACTS AND EXTENDED ABSTRACTS

Last Date for receiving abstracts and extended abstracts is 31st January 2014

AWARDS 2014

The following awards will be presented at the Annual Sessions 2014 of the Institute of Chemistry Ceylon.

- **Dr. C.L de Silva Gold Medal Award**

Awarded for an outstanding research contribution in any branch of Chemical Sciences and/ or the use of such research for National Development during the last five (5) years in Sri Lanka. Credit will be given for the utilization of local raw materials, and where the contribution has already resulted in (i) a publication in a Citation Indexed Journal or (ii) Registering a Patent or (iii) where the contribution has already resulted in a positive impact in the development and innovation in the industry.

- **INSTITUTE OF CHEMISTRY SILVER MEDALS**

Devanathan Memorial Award

Awarded for an exceptional research contribution of an original nature in the field of Physical Chemistry and or related areas, such as Physical-Inorganic, Physical-Organic and Biophysical chemistry.

Chandrasena Memorial Award

Awarded for an exceptional research contribution of an original nature in the field of Organic Chemistry and/ or related areas such as Biochemistry, Pharmacognosy, Molecular Biology and Bioactivity studies.

Ramakrishna Memorial Award

Awarded for an exceptional research contribution of an original nature in the field of Inorganic and/ or Analytical Chemistry and/ or related areas such as Bio-inorganic Chemistry or Bio-analytical Chemistry.

- **INSTITUTE OF CHEMISTRY BRONZE MEDALS**

Kandiah Memorial Awards

Awarded for the best research contribution in Chemistry carried out by a postgraduate student registered for a postgraduate degree by either course work or/ and research at a Higher Educational Institute in Sri Lanka and for work carried out in Sri Lanka, with the exception of special analysis that cannot be done in the country. Such results should be less than 20% of the findings from the work. Sandwich programs carried out partially abroad do not qualify for the award.

Kandiah Award for Basic Chemistry

For research predominately in basic Chemistry (Organic, Inorganic, Physical, and Analytical).

Kandiah Award for Applied Chemistry

For research in Chemistry related areas such as polymer, food, biochemistry, biotechnology, where interdisciplinary research is involved and provided that chemistry has a central role and comprises at least 50% of the content.

Kandiah Memorial Graduateship Award

For the best piece of research in the Chemical Sciences carried out by a Graduate Chemist of the College of Chemical Sciences/ Institute Chemistry Ceylon registered with a Higher Education Institute for a Post Graduate Degree.

- **Professor M. U. S. Sultanbawa Award for Research in Chemistry**

Awarded for the best research paper presented at the Annual Sessions of the Institute of Chemistry Ceylon, for work carried out and completed in Sri Lanka.

Closing date for receiving applications/ nominations for the above awards: 28th February 2014

Further information could be obtained from the Registrar, Institute of Chemistry Ceylon or www.ichemc.edu.lk

Our own Graduate Chemist elected as IChemC Vice-President inaugurated the Graduateship Programme on January 4th - nearly 200 students register but few vacancies still exist for belated registration

The 36th Graduateship Programme of College of Chemical Sciences was Inaugurated by one of our own Graduate Chemists **Mr. K. R Dayananda**, C.Chem, MPhil (Kelaniya), who became the very first CCS Graduate Chemist to be elected as Vice President, Institute of Chemistry recently. We extend our heartiest congratulation to Mr. Dayananda who retired as Senior Research Officer at the Industrial Technology Institute in 2012 and is presently Senior Research Development Manager, Silver Mill Group. Mr. Dayananda has been a very loyal alumnus who has involved himself very closely with the Institute since he graduated on 1984. We look forward to more & more alumni taking on important positions on the Institute.

CHEMEX - 3 Exhibition

CHEMEX 3 to be held from January 22nd to 24th at Adamantane House will include demonstrations, Chemistry Magic Shows, Entertainment items and many other events. It will provide an opportunity for students and the general public to obtain information on various aspects of chemistry including those on **Food, Nano Technology, Polymer industry, Natural Products, Agro Chemicals, Pharmaceuticals, Environment, Toxicology** and appreciate the value and relevance of Chemistry to every day life. A/L seminars will also be held to assist students. The Exhibition will be declared open by **Mr Mevan Pieris**, Past President on Wednesday, 22nd January at 9.00 a.m.

Stand alone Certificate course on Food Chemistry

We are proud to announce that the College is offering a standalone course in **Food Chemistry & Technology** for the very first time. This course covers Food Carbohydrates, Food Lipids, Food Proteins, Sensory Properties (Flavour compounds and pigments in food), Micronutrients, Food Additives (including legislation), Water. The lectures will be conducted by the highly competent professionals in relevant fields.

The course is open for all interested including those who are working on the relevant field and will be held on **Sunday between May and July from 3-6 pm**. It will cost only a nominal Rs. 7500/= for the 15 week course of 45 hours lectures. For more details please visit us on www.ichemc.edu.lk or contact IChemC office.

Constructions of the Adamantane House Extension Completed

Gamini construction has finished the construction of the 6 storey extension to the Adamantane House and is scheduled to be formally opened during the inauguration of the CHEMEX-3 Exhibition on 22nd January 2014. This will enable our acute space problems to be ameliorated. The extension is equipped with a lift, generator & transformer with disability access. We have also incorporated an Open Pent House on the Sixth Level. The building and the refurbishment etc, will cost over Rs 100 millions.

Seminar on Coconut Revival : New Opportunities for the “Tree of Life”

This seminar will be held on **13th February 2014** at Adamantane House, Rajagiriya. The seminar is co-ordinated by **Dr. L S R Arambawela**. The resource persons will be Dr H A Jayantha Gunathilake, Dr. (Ms.) L C P Fernando, Prof. Siromi Samarasinghe, Ms. M. Wijebandara, Prof. Kapila Seneviratne, Prof. D. Mathew, Mr. Manjula Narayana and Ms. Upeka Rajawardene

Ruby Anniversary International Conference

organized by the
College of Chemical Sciences (CCS)
of the
Institute of Chemistry Ceylon (IChemC)

Theme:

Chemical Education & Research for Industrial Development & Sustainable Growth in a Knowledge Based Economy

The International Conference on Chemical Education that is being held on 3rd – 4th April 2014 to commemorate the completion of four decades of formal professional chemical education provided by our institute is expected to be attend large number of distinguish chemist from many countires throughout the world. We are expecting support and international funding from IUPAC, TWAS, Chemical Weapons Convention and RSC to enable a wider participation. The Inauguration on 3rd April at Waters Edge, Capital City will incorporate the 10th CCS Convocation with distinguished Chemist Professor Atta-ur-Rahaman. Former Federal Minister of Higher Education in Pakistan, as Chief Guest, delivering the Convocation Address. An Ex-co meeting of the Federation of Asian Chemical Societies (FACS) will also be held in Colombo in conjunction with the conference on 2nd April 2014.

The Conference Secretariat is located at the Headquarters of the Institute of Chemistry Ceylon at Adamantane House, 341/22, Kotte Road, Rajagiriya, Sri Lanka.

Category of Participants	Overseas Participants	IChemC Members Residing in Sri Lanka	Local Participants
Early Bird Registration Until 31 st January 2014	US \$ 150	LKR 3000.00	LKR 5000.00
Regular Registration Until 28 th February 2014	US \$ 175	LKR 4000.00	LKR 6000.00
Late Registration After 28 th February	US \$ 200	LKR 5000.00	LKR 7000.00

Contact us

Chairman: Prof. J N O Fernando (oleap@ichemc.edu.lk)

Co-Chairs: Prof. H D Gunawardhena (hdg@chem.cmb.ac.lk)

Prof. S Sotheeswaran (sotheeswaran@ichemc.edu.lk)

PUBLICATIONS OF THE INSTITUTE OF CHEMISTRY CEYLON

Monograph	Title	Author	Price
01	Textile Fibers	Mr T Rajasekeram	Rs.50/-
02	Principles of Food Preservation	Prof U Samarajeewa	Rs.75/-
03	Biotechnology	Prof C P D W Mathew	Rs.75/-
04	Recombinant DNA Technology	Prof J Welihinda	Rs.75/-
05	Natural Toxins in Foodstuffs	Prof E R Jansz & Ms A S Perera	Rs.50/-
06	Fat Soluble Vitamins	Prof E R Jansz & Ms S Malavidana	Rs.50/-
07	Nucleic Acid and Protein Synthesis	Prof J Welihinda	Rs.75/-
08	Extraction of Energy from Food	Prof J Welihinda	Rs.50/-
09	Corrosion of Materials	Dr A M M Amirudeen	Rs.75/-
10	Vitamin C-Have all its mysteries been Unravalled ?	Prof E R Jansz & Ms S T C Mahavithanage	Rs.75/-
11	*Environmental Organic Chemistry (second edition)	Prof S Sotheeswaran	Rs.150/- (US \$3)
12	Enzyme Kinetics and Catalysis	Prof (Mrs) S A Deraniyagala	Rs.100/-
13	Insecticides	Prof (Mrs) Sukumal Wimalasena	Rs.95/-
14	Organotransition Metal Catalysts	Dr S P Deraniyagala & Dr M D P De Costa	Rs.75/-
15	Some Important Aspects of Polymer Characterization	Dr L Karunanayake	Rs.75/-
16	Hard & Soft Acids & Bases	Prof (Mrs) Janitha A Liyanage	Rs.65/-
17	Chemistry of Metallocenes	Dr Sarath D Perera	Rs.65/-
18	Lasers	Dr P P M Jayaweera	Rs.65/-
19	*Life and Metals	Prof (Mrs) Janitha A Liyanage	Rs.75/-
21	*Silicones	Prof Sudantha Liyanage	Rs.65/-
22	Pericyclic Reactions: Theory and Applications	Dr M D P De Costa	Rs.65/-
23	Inorganic NMR Spectroscopy	Prof K S D Perera	Rs.65/-
24	Industrial Polymers	Dr L Karunanayake	Rs.75/-
25	*NMR Spectroscopy	Dr (Mrs) D T U Abeytunga	Rs.65/-
26	Mosquito Coils and Consumer	Ms D K Galpoththage	Rs.100/-
27	Atomic Absorption Spectrometry	Dr K A S Pathiratne	Rs.100/-
28	Iron Management on Biological Systems	Dr (Ms) R D Wijesekera	Rs.100/-
29	Nutritional Antioxidants	Prof. (Mrs) Sukumal Wimalasena	Rs.100/-
30	*f-Block Elements	Prof Sudantha Liyanage	Rs.65/-
31	Scientific Measurements and Calculations	Prof (Mrs) S A Deraniyagala	Rs. 80/-

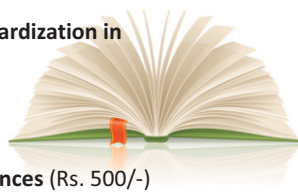
* - Second Edition /new print published on popular demand

CCS Publications

01	Functional Group Analysis in Organic Chemistry	Prof A A L Gunatilake	Rs. 175/-
02	Zinc Metalloproteins	Prof S Sotheeswaran Prof (Ms) R D Wijesekera	Rs. 175/-

General Publications

- ★ **Chemist & The Environment** (Rs.300/-)
- ★ **Infrastructure Support Services for Industrial Development** (Rs.200/-)
- ★ **Chemical Industries in Sri Lanka – Part II** (Members: Rs. 200/-, Non-members: Rs.275/-)
- ★ **Proceedings of the Workshop on the Technological aspects of the Production & Processing of Essential oils in Sri Lanka** (Rs.100/-)
- ★ **Proceedings of the Training Seminar on Towards a Cleaner Industrial Environment in the New Millennium** (Rs.150/-)
- ★ **A-Level Chemistry Facts, Patterns & Principles by Dr. Seetha I Rodrigo** (Rs.1500/-)
- ★ **Proceedings of the Prof R S Ramakrishna Memorial Training Seminar on Modern Analytical Methods** (Rs.200/-)
- ★ **Historical Accounts of the Educational Activities (1972 - 2004)** (Rs.350/-)
- ★ **Proceedings of the Training Seminar cum Workshop on Sampling, Statistics and Standardization in Chemical Analysis and Environmental Management** (Rs.150/-)
- ★ **Polymer Industries of Sri Lanka** (Rs. 200/-)
- ★ **Industry & Environment** (Rs. 200/-)
- ★ **Herbal Medicine Phytopharmaceuticals and Other Natural Products: Trends and Advances** (Rs. 500/-)
- ★ **Chemistry in Sri Lanka** (Rs. 150/-)





RSC NEWS

THE ROYAL SOCIETY OF CHEMISTRY SRI LANKA SECTION

1. Membership

According to the records sent to us from the parent body, a breakdown of the membership is as follows:-

Category	Number
CChem, FRSC	11
FRSC	05
CChem, MRSC	10
MRSC	20
AMRSC	08
Affiliate /Under Graduate.	<u>06</u>
Total Membership as at July 2013	<u>60</u>

2. Committee of Management

The following were elected to the Committee at the 52nd Annual General Meeting held on 27th July 2013.

Chairman	- Prof. Sudantha Liyanage
Vice Chairman	- Mr. W J P D Jayalath
Chairman Elect	- Mr. I M S Herath
Hony. Secretary	- Dr. Positha Premaratne
Hony. Treasurer	- Mr. R M G B Rajanayake

Committee Members - Prof. W S Fernando
Dr. M P Deeyamulla
Mr. W A P Silva
Mr. S Perasiriyan
Mr. Sulith Liyanage
Dr. P A N Punyasiri

3 Activities

3.1 Contributions to Activities of the Institute of Chemistry Ceylon

(a) Full page advertisement of "Chemistry in Sri Lanka".

(b) Contribution for the Interschool Chemistry Quiz

(c) Award for the Best Performance at the Graduate ship Examination in Chemistry Part II Theory Examination

(d) Contributions for the International Conference

3.2 All - Island Inter School Chemistry Essay Competition.

3.3 Inter - University Chemistry Competition.

3.4 A/L teacher workshops.

3.5 Advanced Level chemistry seminar.

3.6 Book donation programmes

3.7 Industrial Visit.

3.8 Collaborations with SLLAS -E2 Work Shop and Seminars

3.9 Supporting Chemical Societies of Universities of Sri Lanka

4. Web Site

The members are reminded of the web site of our Section, the address of which is as follows:-
www.rsc.org/Membership/Networking/InternationalSections/SriLanka/index.asp.

Dr. Positha Premaratne
Hony Secretary