CHEMMUNIQUÈ

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DEAN'S MESSAGE

Chemmuniqué is the news letter published by department of chemistry since 2011. It took birth in the auspicious 'International Year of Chemistry' (as declared by IUPAC). Since then it has served the purpose of popularizing chemistry among students and faculty through a range of articles published every year. Now in its 9th year it is bringing good articles, poems and new information contributed by students of chemistry. Chemmuniqué is a platform for students to highlight their talents in the area of chemistry through articles, poems and thought provoking ideas.

I wish to thank each contributor and the editorial team for their effort in bringing this issue of Chemmuniqué through their keen interest and effort. I am sure the students and the faculty will carry this tradition forward.

Dr. GEORGE THOMAS
DEAN OF SCIENCES

FROM THE EDITOR'S DESK

Yet another academic year on the way out.

This year too we take pride in bringing out Chemmuniqué. The name is a hybridisation of two words 'Chemistry', which is what binds us together and 'Communiqué' which means to make a statement. This was started as a venture to help enable students of Chemistry to express their views, opinions and other creative articles and communicate them to the chemistry fraternity. I take pride in presenting the articles which are primarily from our students.

PRASAD PRHALAD PUJAR
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Disclaimer:
The opinions views and words expressed by the students are their own and the editors are have not verified them for factual veracity.

HEAVY METAL POLLUTION IN BELLANDUR LAKE

Bellandur lake, located in the south east part of Bangalore is one of the largest lakes in Bangalore. It is 130 years old and spread across an area of 892 acres. It receives water from three different lakes and it flows into the Varthur lake.
It was a lifeline for several villages surrounding it. It was used by the people to grow vegetables, cultivate paddy and for recreational activities like boating, fishing etc. Today it is a cesspool of sewage and a receptor for more than 70 million gallons of sewage per day. The contaminated waters are send to Varthur lake and it joined the Pennar river.
Few years back, the lake started spewing froth which was about 10 feet high. The smelly froth has caused inconvenience to the busy localities around the lake. Also, frequent fires have gripped the city in horror as the residents watched the fires rage and fill the sky for the fifth time since 2015. It was carried up in the air due to the wind and spread across the surrounding areas. This started becoming a regular phenomenon during heavy rains. The lake was highly polluted with industrial effluents and toxic metals that it became the largest septic tank in the city, due to “sheer callousness and indifference”, said the green court and ordered the Karnataka government to take the necessary action.
Recently, in February 2016, the lake caught fire when a garbage dump around it was set ablaze. The dry hyacinth plants further intensified the situation. The locals claimed that dry grass was regularly burned here without the supervision of garbage collectors. The area was covered in thick smoke and engulfed the entire lake. It caused panic among the residents and motorists on Sarjapur road. 5000 army personnel had to be deployed to put off the fire, only after a 7 hour long battle.
Studies about the pollution levels in the lake
Studies proves that 40% of the domestic sewage and industrial effluents flow into the lake every day. This leads to the formation of vegetative cover of weeds. This leads to eutrophication, which releases methane making the lake susceptible to fire.
Recent studies presented at the National Institute of Advanced Studies, IISC revealed that metals like cadmium and chromium has entered the food chain. This is because many communities uses this water to grow vegetables. This is believed to be the cause of increasing kidney failures and bone marrow cancer in the city.
Rashmi Verma and Pratima Dwivedi have worked on the various sources and harmful effects of these heavy metals. E waste, thermal power plants, mining, industrial wastes, hospital wastes, ceramic, bangles and battery industry are the several sources of pollution in the lake. These effluents are released into healthy water bodies which results in contamination. They get introduced into the lower levels of the food chain, which imbalances the food web. Heavy metals cause gastrointestinal disorders, diarrhoea stomatitis, tremors, haemoglobinuria, paralysis, vomiting etc. The fumes inhaled or the volatile compounds, can be carcinogenic, neurotoxic, mutagenic, teratogenic etc.
H Lokeshwari and GT Chandrappa studied the extent of heavy metal contamination in lake waters. Samples from Bellandur lake was collected in different sterilized polythene bags. These were filtered and preserved with 2ml nitric acid to prevent contamination of metals. They were concentrated ten times in water bath and was placed for digestion using concentrated nitric acid.
Heavy metals were analysed using flame atomic absorption spectrophotometer. The results show that the various metals concentration exceeds the desirable limits fixed by the Pollution Control Board, Government of India. While iron was two-fold higher than desirable levels, metals like zinc, copper, nickel, chromium, lead and cadmium were two times, nine times, four times, six times, six times, nine times and twenty-three times greater than the desirable limit. It was observed that iron, chromium, lead showed 50% more concentration during rainy season due to surface run off while cadmium showed high concentration during the dry season.
Importance of Bellandur Lake :
People have very precious relationships with these lakes. Fodder is carried in rafts to several parts of the city including Bennaraghatta biological park. “As many as 5000 cows need this lake”, said one of the villagers.
Revival plans of Bellandur lake:
The Karnataka Government, Bangalore Development Authority (BDA), along with Bangalore Water Sewage and Sewerage Board (BWSSB), and Karnataka State Pollution Control Board (KSPCB) are looking into this matter seriously. The residents of the area and the activists have taken several steps to combat this problem. Several petitions were filed and campaigns were held saying “Save Bellandur, Save Bangalore”.
However, the BDA recently said that Bellandur lake will be de-weeded and de-stilted by 2021. Steps will be taken to remove the construction debris from the bed of the lake. Fencing of the Bellandur lake boundary, sluice gates were set up on Varthur lake.

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TETRATHIAFULVALENE DONOR UNITS AS FUNCTIONALIZATION FOR CONJUGATED POLYMERS

Polymers are generally insulators, but their oxidised states are conducting in nature. These intrinsically conducting polymers have wide variety of applications as an electrode substrate for many electrochemical studies. The delocalization of the electrons along the backbone of the polymer chain is the reason for conductivity. Polythiophene, polyaniline, polypyrrole. Etc are very few of them. One among the important fact is that by substituting different potentially active groups will enhance the conducting nature of these polymers. This has drawn attention of researchers to develop more and more substituted polymers with better conductivity and solubility in organic solvents. Alkyl, flouro alkyl, alkylthio, alkoxy, aryl, thiol, amino, cyano, ester, ether, carboxylic acid, sulfonate are some of the functionalization's done on polymers. Studies have proven that the incorporation of these functionalization's have increased the conjugation length of the polymer chain, they provide a better oxidative doping stability and their Pi-Pi stacking distance have lowered. Thus the conductivity of the polymers will be enhanced by these functionalization's.

Tetrathiafulvalene is a different class of electroactive material with exceptional stability. The high electrical conductivity of TTF units can be attributed to their following features(1) planarity(2)high symmetry which promotes charge delocalization thereby minimizing columbic repulsions(3) ability to undergo oxidation at mild potentials to give stable radical cation. The high level of stability observed for the oxidised TTF Pi electron system arises from the aromatic nature of the oxidised 1,3-dithiolium rings and this has triggered tremendous efforts directed towards the synthesis of compounds with TTF donor units.

Combining the exceptional donor strength of TTF and excellent film forming properties of the conjugated polymers open up the possibility to create promising materials with interesting redox behaviour

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CONDUCTING POLYMERS AND ITS APPLICATIONS

Characteristics that are desired for a good polymer are high electrical conductivity, high stability and solubility. One class of polymers called the “conducting polymers” are organic polymers which may have metallic type conductivity or can be semiconductor too. Their conductivity is expected to be seen because of -extended conjugation. Further, doping phenomenon led to a dramatic increase in the conductivity of such conjugated polymers to values as high as 105 S/cm. Traditional polymers such as polyethylene or polypropylene are made up of sigma bonds. Hence the charge created on one of the atom in the polymer is not mobile. In π-extended conjugated polymers i.e., in conducting polymers, the charge generated is mobile, due to this mobility of charge, they are electrically conducting. Major problem of these conducting polymers is their solubility. The presence of extended conjugation along the polymer backbone, the chains possess strong interactions and they are totally rigid. Most recently, however, it was seen that introducing lateral substituents the conjugated polymers can be made soluble. Today doped form of conducting polymers are extensively used. A typical example of a laterally substituted conjugated polymers which has been extensively investigated is poly (3-hexyl thiophene). Few interesting applications of conducting polymers are in

1. Polymeric batteries- first application of conducting polymers was light weight batteries. Polypyrrole / polyaniline as positive electrodes and Li-Al alloy as negative electrode exhibited most desirable properties of a battery.
2. Electrochromic display – electrochromic display utilizes the electro chemical doping and undoping of conducting polymers. The effect is seen in change of color upon application of an electric potential.
3. Light emitting diodes- LED’s nowadays seem to be a great field of research and conducting polymers can be used for LED’s because they show photoluminescence and electroluminescence property.
4. Biomedical application- conducting polymers are used as biosensors, one such biosensors detects presence of glucose and its concentration in the body.

Thus conducting polymers are now of keen interest for many researchers due to their wide application ranging from batteries to biosensors.

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CONVERSION OF AIR POLLUTANTS TO USEFUL CHEMICAL REAGENTS

A novel technique of converting toxic air pollutants produced by burning fossil fuels can be captured from the exhaust gas stream into useful industrial chemicals using only water and air was discovered using new advanced material developed by an international team of scientists. The title of the journal was “Capture of nitrogen dioxide and conversion to nitric acid in a porous metal–organic framework” was published in Nature journal in 2019.

New research led by The University of Manchester, has developed a metal-organic framework (MOF) material that provides a selective, fully reversible and repeatable capability to capture nitrogen dioxide (NO_2), a toxic air pollutant produced particularly by diesel and bio-fuel use. The NO_2 can then be easily converted into nitric acid, a multi-billion dollar industry with uses including, agricultural fertilizer for crops; rocket propellant and nylon.

MOFs are tiny three-dimensional structures which are porous and can trap gasses inside, acting like cages. The internal empty spaces in MOFs can be vast for their size, just one gram of material can have a surface area equivalent to a football pitch.

The highly efficient mechanism in this new MOF was characterized by researchers using neutron scattering and synchrotron X-ray diffraction at the Department of Energy’s Oak Ridge National Laboratory and Berkeley National Laboratory, respectively. The team also used the National Service for Electron Paramagnetic Resonance Spectroscopy at Manchester to study the mechanism of adsorption of NO_2 in MFM-520.

The technology could lead to air pollution control and help remedy the negative impact nitrogen dioxide has on the environment.

Asin Nature Chemistry, the material, named MFM-520, can capture nitrogen dioxide at ambient pressures and temperatures -- even at low concentrations and during flow -- in the presence of moisture, sulfur dioxide and carbon dioxide. Despite the highly reactive nature of the pollutant, MFM-520 proved capable of being fully regenerated multiple times by degassing or by treatment with water in air -- a process that also converts the nitrogen dioxide into nitric acid.

As part of the research, the scientists used neutron spectroscopy and computational techniques at ORNL to precisely characterize how MFM-520 captures nitrogen dioxide molecules.
In the past, capturing greenhouse and toxic gases from the atmosphere was a challenge because of their relatively low concentrations and because water in the air competes and can often affect negatively the separation of targeted gas molecules from other gases. Another issue was finding a practical way to filter out and convert captured gases into useful, value-added products. The MFM-520 material offers solutions to many of these challenges.

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GENERATING LIGHT USING THE DARKNESS OF NIGHT

This is possible today thanks to a group of scientists from University of California and Stanford University who created a device which allows the production of electricity in the night or where there is temperature difference, unlike the solar powered cells which work only in the presence of sunlight. The device works on the principle of radiative heat exchange with space, the cold outer space acts as a cold sink and the ambient air on earth's atmosphere acts as the heat source, thus a heat engine could be produced which generates electricity at night time. The setup is made using a commercial thermo-electric generator where the whole setup is covered using polystyrene covered in aluminized mylar to minimise heat loss and a infrared-transparent wind cover which is made with LD polystyrene 12.5 microns thick, the thermal emitter was a 200 mm aluminium painted in black and was adhered to the cold side using a thermal paste to the cold side of the thermoelectric module from Marlow industries

Thermo-electric generator works like any other thermo couple where the cold side of the thermo couple is in junction with a hot side, which is heated by an external source creating a temperature difference at the junction of the couple creates potential difference which can be used to generate electricity and depending upon the material and temperature difference greater will be the magnitude of electricity generated.

Thermal emitter facing towards the night sky acts as the cold sink to the thermo electric module and the emitter continuously radiates heat to the night sky and the hot side keeps getting hot due to the natural convection. This generates a temperature difference which produces electricity. This electricity can be directly harvested from the thermo-electric generator. The setup that the scientists made showed excellent results with a voltage sweep showed a short circuit current, Jsc=44mA and open circuit voltage of Voc=79 mV. This gives a maximum power output of 0.8mW generated from thermoelectric module. Normalizing this to area of thermal emitter it corresponds to 25mWh/m2. The emitter was always 4-5 oC lower than ambient temperature which was measured by a thermocouple, and the hot side was always equalised to the ambient temperatures. These numbers may seem uncertain but major application they show is lighting. The thermoelectric module was connected to a DC-DC booster connected to a white LED. According to the scientists the LED was working at 10% its maximum brightness.

This device is very cheap and yet functional, the scientists created this device initially with just $30 and it finds a lot of applications, it gives the electricity generation in remote places where electric grid has not been placed, we can create heat sensors in cold areas and since this device does not use any battery the only limit of its lifetime is the lifetime of thermo-electric generator itself. We can get temperature differences between the earth’s surface and the atmosphere. The main advantage of this device is that it is not constrained to the source of heat unlike the conventional one which works on the human movement produced heat, human heat. Their research towards producing light from the darkness of a night sky was extremely successful and opened up areas towards new scientific and energy generation.

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ENZYME ENCAPSULATION Of HOF HOSTS

Enzymes are bio-macromolecular catalysts that enhance significantly accelerated chemical reactions in the living cells. Extensive researchers have been keen to harness their attributes towards mimicking enzymatic molecular catalysts — such as their high activities and substrate selectivity, and some useful enzymatic materials have also been generated for the pharmaceuticals and food industries for a variety of applications in biotechnology, as exemplified by xylose isomerase for the production of high-fructose corn syrup, and penicillin amidase in the preparation of semi-synthetic penicillin. Enzymes are notoriously fragile, however. A variety of supports have been investigated to prevent their denaturation and preserve their native activity under a range of conditions. The researches have shown that a biocompatible hydrogen-bonded organic framework (HOF) is very suitable and capable of successfully protecting two native enzymes from harsh environments. Porous materials are fascinating hosts for a wide range of patrons, among the bio-macromolecules. Enzymes have been capsulized within mesoporous silicas, metal–organic frameworks (MOFs) and covalent organic frameworks (COFs) and investigated for catalysis mechanisms. Traditionally, the enzyme had been consolidated into the pre-synthesized porous matrices whose approach inherently relies on mesoporous hosts with channels large enough to diffuse enzyme into it. To circumvent this deterrent, microporous MOFs have also been grown directly around enzymes. The channels of the host material undergo diffusion of substrate and products in and out to reach the enzyme's active site yet preventing large extent of enzyme leaching. This approach, mostly, requires MOFs that can erect and remain inert in the biocompatible conditions mandatory for enzyme usance, thus limiting the type of materials amenable to this strategy. It has mostly been shown with zeolite imidazolate frameworks (ZIFs). Another class of porous materials, HOFs which consist of discrete organic molecules held together by hydrogen bonds have recently signified a set of properties that makes them a promising candidate for enzyme protection. They exhibit good solution processability, high crystallinity, ease of purification, permanent porosity, biocompatibility and potentially high stability in aqueous conditions. Enzymes are structurally similar to HOFs than other porous materials, emphasizing the fact that they are a cluster of amino acid chains that fold into 3D structures through H-bonding, exhibiting cavities or channels for the recognition of substrates.

In the study, Liang and co-workers turned to a family cluster of HOFs known to form, and remained stable in water and polar solvents. Charge-assisted H-bonding of tetraamidinium and tetracarboxylate building units leading to the formation of a HOF consisting a six-fold interpenetrated framework of diamondoid topology. When the material is assembled in the presence of an enzyme, amidinium cations accumulate at the protein surface facilitating the formation of an enzyme HOF bio-composite. Similarly described with ZIFs, this synthetic approach results in enzymes being encapsulated in a HOF with channels that are far narrower than themselves. Furthermore, in contrast to the polar solvents or high temperature, this assembly can be rapidly achieved in aqueous solutions at room temperature, harmful to enzymes — that are typically required for the desolvation of mesoporous materials.

Although some highly porous and stable HOFs have been prepared— with accessible pore surface areas up to thousands of meters squared per gram, from which very few amidinium-based HOFs shows permanent porosity in the solid state. It is thus perhaps not surprising that here the channels of both the HOF and the enzyme– HOF materials collapse on desolvation. Permanent porosity, however, is not necessary for enzymatic catalysis; the fact that the host matrix retains its pore structure in solution is sufficient.
The activity of two different enzymes encapsulated within the pores of this HOF was evaluated — catalase, which propagates the decomposition of hydrogen peroxide, and alcohol oxidase. Both enzyme–HOF composites perpetuate the crystallinity of the parent HOF and preserved the activity of the native enzyme in aqueous solution. Activity studies under relatively harsh conditions such as exposure to elevated temperatures (up to 60 °C), the presence of the proteolytic enzyme trypsin that hydrolyses catalase, or the presence of the denaturing agent urea showed that the enzymes were well protected within the HOF: the catalase–HOF bio-composite retained over 75% of the enzyme's original catalytic activity, in contrast to below 10% for free catalase under the same conditions. The fact that the enzymes are well protected from urea which can easily diffuse into the channels of the host matrix is intriguing.
The researchers ascribed this to the tight intermolecular interactions at the enzyme HOF interfaces and the limited space provided for enzyme unfolding (denaturation). Similarly, investigations with the larger alcohol oxidase also showed that the HOF coating protected the enzyme in the same conditions. It was noted that this encapsulation approach, despite providing good protection from environmental factors, slow down the enzymatic catalytic rate owing to the mass transportation issue.
Further studies are needed to better understand the details of both the encapsulation process and the biocatalytic reactions within the bio-composite matrices, and, in turn, rationally modified the practical performance of the encapsulated enzymes. Another crucial issue relates to the diffusion rates of substrates, intermediates and products in the biocatalytic reactions within the porous matrices. HOFs with larger channel sizes and certain degree of framework rigidity might facilitate the mass transportation of the substrates and products, and thus maintain the high catalytic rates of the enzymes. Gaining insight into these aspects may lead to enzyme HOF bio-composites such as those described here significantly facilitating enzymatic biotechnology.

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PURPLE CARROTS

Cosmic Purple, Purple Haze and Purple Dragon

No, these are not the names of Barbie and her fashionista side-kicks. These are the names of purple carrot varieties.

The perfectly smooth uniformly shaped torpedoes that are so versatile in the Indian cuisine from Gajar ka halwa to carrot poriyal were originally not orange. They were the sparkling Barbie colour - Purple. This deep royal colour of the carrot was used as clothing dye by the Afghan royals.

The purple carrot is now making a comeback in the western market. The main attraction of this is its health benefits. The pigment Anthocyanin that gives its colour is a very important. Anthocyanin has anti-oxidative properties that are popularly seen in Green tea. These pigments act as powerful antioxidants that protect key cell components by grabbing and holding on to harmful free radicals in the body. Anthocyanins also help prevent heart disease by slowing down blood clotting processes and are good anti-inflammatory agents. Purple carrots also have high beta carotene content.

Purple carrot, the ancestor of orange carrots originated from Afghanistan and turkey before the 900s. Regions of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan were centres rich of these carrots. In the 1100s, Carrot cultivation spread to Spain via the Middle East and North Africa. By the time, the humble purple carrot made it to Europe it had genetically mutated to white and orange in colour. This carrot type spread to the West and now dominates the entire world.

This lead for the purple carrot to vanish from mainstream society. As is the habit of the west to popularize old customs as its own – The purple carrot has made a comeback as a healthier variant to the orange carrot.

The purple carrot given to its anthocyanin pigment has the ability to reverse the effects of high fat diet, high blood pressure, cardiac fibrosis and abdominal fat deposition.

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CATALYTIC CONVERSION OF CARBON DIOXIDE TO FUEL

The rising level of Carbon di oxide in the atmosphere has been a cause of concern for many years. If CO2 in the atmosphere can be converted efficiently to another potential renewable fuel , there will be much less risk associated in the environment like reduction in the greenhouse gas emissions. This in itself is a challenge since CO2 is a relatively stable and unreactive molecule. Mostly catalysts that uses carbon di oxide undergoes reduction reactions to form either carbon mono oxide or formic acid, but lacks the selectivity to reduce the compounds further to convert it into methanol, ethane etc. Scientists have made use of sunlight and a copper catalyst to convert CO2 to methanol. Upon exposure to sunlight, the photocatalytic cuprous oxide produces electrons and has a negative conduction band , making the electrons to have more potential energy while acting as a semiconductor . The excitation of electrons creates a positive hole in the catalyst's lower energy valence band that can oxidize water. The catalyst provides a surface to bind with CO2 resulting in a bend structure diminishing the amount of energy it takes to reduce . The conversion of CO2 to methanol via catalytic hydrogenation with H2 is one of the easiest production for methanol due to advantages like separation of fluid from solid catalyst . Cu-ZnO/ZrO2 catalyst aids in the dispersion of Cu to oxygen . Molecular catalysts where the ligand molecules are bound to metal ions makes Use of cobalt phthalocyanine dispersed on carbon nanotubes which has proven to be highly efficient since it has high selectivity for electrochemical reduction into methanol. The reduction to CO takes place when the cobalt catalyst is immobolised on carbon nanotubes , with further reduction to methanol while applying high voltages in the electrochemical cell. However it was identified that the catalytic activity of Cobalt Phthalocyanine system loses in about five hours due to the degradation of Phthalocyanine ligand. The modification by substituting amino substituent increased the duration of activity to 12 hours. The use of Fe3O4 with alkali metals like sodium enhances surface basicity and carburization of iron based catalyst making co2 hydrogenation to light olefins. The combination with zeolites increases olefin oligomerisation reaction to varying degrees, this acts as a highly efficient multifunctional catalyst when in combination with HZSM-5 zeolite for conversion to gasoline range hydrocarbons since it shows selectivity towards C5-C11hydrocarbons, the acidity of the silicon di oxide and aluminium tri oxide ration of the zeolite ,stronger acidic conditions leads to cracking whereas weakly acidic is not beneficial for oligomerisation, pore structure affects hydrocarbon distribution. Formulation of palladium and copper in the atomic ratio range of .3 to .4 yielded the most efficient conversion to methanol whilst using nanoparticles of the catalyst dispersed on a porous support metal which increases the surface area of the catalyst. The carbon dioxide hydrogenation process decomposes water to create hydrogen gas using renewable energy, which bonds with carbon di oxide on the surface of the catalyst to create methanol.

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STRONGER UNDER PRESSURE!

As per scientists report in Physical Review letters, November 11, lead becomes stronger than steel under extreme pressures. Under normal conditions, lead is a relatively soft metal which can be easily scratched with a finger nail, but when compressed under extreme pressures it becomes hard and strong – stronger than steel. To study this a sample of lead was blasted with lasers and the pressure within the sample reached about 400 gigapascals (similar to the pressure found within the earth's core). The sample endured more stress before it deformed indicating that the metal was 250 times as strong as lead under normal conditions and almost 10 times as strong as steel.

When materials are compressed, their properties can change drastically. For example, hydrogen which is normally a gas turns into a metal under high pressures. Understanding how substances change in response to pressure might be important in improving designs of protective gear such as bullet-proof vests.

Researchers concluded that pressure alters the crystal structure of lead, thereby causing a rearrangement in its crystal lattice. This resulted in a stronger metal.

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METAL - ORGANIC FRAMEWORK AS WATER HARVESTER

Water is one of the most important requisite for survival on earth. Thus, providing water to meet the needs of the ever growing population is a huge challenge. Out of the total amount of water on earth, only 2.5% is available as fresh water. The rest of it is locked in the form of glaciers or as ground water and is hence not available for use. Most of the countries facing water scarcity are surrounded by land on all sides and thus alternative ways need to be designed to access drinking water. Humidity in the earth's atmosphere is one such alternative. Here, water is held in the form of drops and vapour and thus adds to the freshwater resources. Consequently, the large-scale water problem could be dealt with by making use of humidity. For water harvesting, even from dry air, adsorption based devices have been employed. At first, the conventional desiccants such as silica gel, $CaCl_2$ or zeolites were used. But they have low working capacities in autonomous devices due to their intensive regeneration energy and affinity to water. Here came the necessity for a novel adsorbent that should have high chemical stability and alterable affinity to water and also a flexible pore size. Metal–organic frameworks (MOFs) are a potential candidate that meets all the afore-said criteria and the desired water sorption properties. Metal–organic frameworks are porous and crystalline hybrids of inorganic and organic materials. They are formed by the organic 'linker' molecules surrounding an array of positively charged metal ions. MOFs have an extremely large internal surface area due to the hollow cage-like structure formed by the linkers and the metal ions.

Hyunho Kim in his paper titled, “Water harvesting from air with metal-organic frameworks powered by natural sunlight” has reported the construction of a device based on porous MOF-801 [Zr6O4(OH)4(fumarate)6]. The device traps water from the atmosphere making use of the heat from sunlight and is efficient in harvesting 2.8 litres of water per kg of MOF daily without any extra energy input. In one of his subsequent publications titled, “Adsorption-based atmospheric water harvesting device for arid climates”, he has depicted an air-cooled sorbent-based device for harvesting of water from the atmosphere using the same MOF as described earlier in arid areas as well as sub-zero dew points. The as prepared device could deliver about 0.25 litres of water per kg of MOF for a single daily cycle.

Farhad Fathieh et.al in their paper, “Practical water production from desert air” accounts for an experiment in which a sample of 1.2 kg of MOF-801 was tested both in the laboratory and in the desert of Arizona, USA. Using sunlight and natural cooling as the only source of energy, the device produced 100 g of water per kg of MOF-801 per cycle. There is also a mention of a more productive aluminium based MOF-303 which produces more than twice the amount the water.

Further, works on MOF-303 were carried out by Nikita Hanikel, the author of the publication “Rapid Cycling and Exceptional Yield in a Metal-Organic Framework Water Harvester”. The afore-mentioned MOF can complete one water harvesting cycle within minutes under mild temperature conditions. Better results were obtained and thus concluding that sorbents that have rapid water sorption dynamics is more crucial than those having high water capacities to reach the level of water production to meet the human needs. Metal-Organic Framework is thus an emerging field and numerous works are being carried out with regard to its applications. MOF as a water harvester is a recently developing area and a lot more research needs to be done with regard to device-engineering and much more for the wide range production and supply of water to eradicate water scarcity as a whole.

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‘RASATANTRA’ IN VEDIC AGE; AN INSIGHT TO THE DEVELOPMENT OF CHEMICAL SCIENCES IN ANCIENT INDIA

Vedas; often deemed as the lone postulate of ‘Dharma’ cogently incorporates various mysterious chemical theories. Scriptures and religious manuscripts are often the reflection of the existing perceptions and beliefs. The societal reformations and transformations in Babylonian, Aserian, Chinese, Greek and Indus valley civilisations accounted for primary development of chemical sciences. The glorious Indian myth of all-powerful ‘devas’ is mystically intertwined with certain scientific notions created by our ancestors.

“It was a weapon, so powerful thatit could destroy the earth in an instant. A greatsoaring sound in smoke and flames, And on its sits death…”

-The Ramayana

Brahmastra, which is stimulated by atomic energy can be equated with modern nuclear weapons. Ancient descriptions about the eighteen purification steps involved in alchemising mercury, detailed explanations about the 7 metals, references to metals, minerals and ores etc. in Vedas can be regarded as a nascent, but potent progression of chemistry in Vedic age. During the 1800s the steel made in India invited the attention of many foreign traders. The steel manufactured in India was considered to be mightier than the Swedish steel- which was renowned for its durability and strength. A detailed account of Vedic people involved in tanning, dyeing and polishing pottery is inscribed in the ‘Rig Veda’, this gives an insight to the early knowledge of the people in controlling and adjusting kiln temperature. From the Holy fire and divine sacraments to the fundamentals of building a civilisation, the life of the Vedic people was massively influenced by science.

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AIRBAGS, ITS ALL ABOUT CHEMISTRY BEHIND IT!

We use automobiles and guess what, accidents are called so, because it is not something we call for! As these accidents is not in our hands but definetly safety is in our hands and it is one's responsibility to be aware of oneself. Yes, airbags are the ones which can save the main region of one's body, head ....face! But how does this happen? Well it's just a set of few chemical reactions, but definetly not as simple as its said... Nowadays airbags are mandatory in new cars.
During the course of airbag's practical tests, it showed that for it to be a protective device, the bag must deploy and inflate within 40 milliseconds. These technological difficulties lead to 30-year span between the first patent and the common availability of airbags.
Above all this, there also arises a question as to what percentage of airbag usage is literally a safety or does its advantages outnumber its disadvantages?
How does airbags essentially work?
Timing is one of important factor in the airbag's ability to save lives in a head-on collision. As already said an airbag must be able to deploy in a matter of milliseconds from the initial collision impact. At the same time it must also be prevented from deploying when there is no collision of any kind which includes road bumps and potholes. The first component 'sensor' detects any collisions and trigger immediate deployment of airbag. A steel ball that is employed in crash sensor slides inside a smooth bore which is usually held in place by a permanent magnet or a stiff spring. In cases of head-on crash, the ball suddenly moves forward and turns on an electrical circuit, initiating the process of inflating the airbag.
As the electrical circuit is turned on by the sensor, a pellet of sodium azide(NaN_3) is ignited. As a result of rapid reactions, nitrogen gas (N_2) is generated and fills the bag. But the real trick here is that how effectively and efficiently the airbag inflates and deflates during the course of collision. Because ideally the body of the driver should not hit the airbag while it is still inflating. In order for airbag to provide a protective cushion it must begin to deflate by the time the body hits it. Otherwise, the high pressure inside the bag would create a surface as hard as stone and not the cushion one would want to crash into!
Well, now arises the real chemistry happening inside the airbag....inside the airbag is a gas generator containing a mixture of sodium azide(NaN_3), potassium nitrate(KNO_3), and silicon dioxide(SiO_2) . When there is a collision, nitrogen gas is produced to fill the airbag and convert NaN_3, which is highly toxic (The maximum concentration of NaN_3 allowed in the workplace is 0.2 mg/m3 air.), to harmless glass. Sodium azide(NaN_3) can decompose at 300oC to produce sodium metal (Na) and nitrogen gas (N_2). This high temperature signal is generated by the signal from the deceleration sensor which ignites the gas-generator mixture by an electrical impulse. The purpose of the KNO_3 and SiO_2 is to remove the sodium metal (which is highly reactive and expolsive) by converting it to a harmless material. First, the sodium reacts with potassium nitrate (KNO_3) to produce potassium oxide (K_2O), sodium oxide (Na_2O), and additional N_2 gas. The N_2 generated in this second reaction also fills the airbag, and the metal oxides react with silicon dioxide (SiO_2) in a final reaction to produce silicate glass, which is harmless and stable.
In conclusion, airbags has been shown to significantly reduce the number and severity of injuries and deaths in head-on automobile collisions.

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CORROSION INHIBITION USING SUPER HYDROPHOBIC FILMS

Corrosion is been one of the major problem prevailing all over the world, mainly in industries which focuses in manufacturing various metal based products. Corrosion is a natural process taking place which leads to gradual destruction of materials, generally metals due to moisture, air and other environmental factors. Many techniques are been implemented for inhibiting corrosion which includes protective coating using paints, sacrificial coating using metals, galvanization for zinc and cathodic protection. Although these methods have been followed extensively, due to certain drawbacks a new method was developed since 2004. Researches started to work on the development of “superhydrophobic” or water repellent films which was incorporated from a natural phenomenon that’s is observed in lotus leaves. The hydrophobic nature of the lotus leaves has been replaced by chemicals having same property.

Durability of the film is one of the key factor when a super hydrophobic film is considered. The two factors that determines durability is surface roughness and surface energy. These two factors has to be governed simultaneously. Many fabrication methods such as template based films, electrospinning, sol gel, layer by layer, etching and electrochemical deposition methods have been developed based on the above mentioned two factors. Superhydrophobic coatings have wide range of applications in industry which includes anti-fog coating, anti-freeze surfaces, oil and water separation, anti-bacterial surfaces and medical applications. Major concern for most of the researchers is on improving corrosion resistance which is the major problem of the society causing large damages. Although corrosion damage cannot be stopped completely, it can be minimized to a certain extent.

It is believed that by creating an air layer between the surface and corrosive environment, super hydrophobic surface prevents basically the contact between corrosive ions and surface, thereby increasing the corrosive resistance. Most superhydrophobic surfaces tend to lose their super hydrophobic property when exposed which is an undesirable property and overcoming this drawback has been a challenging work for researchers around the globe.

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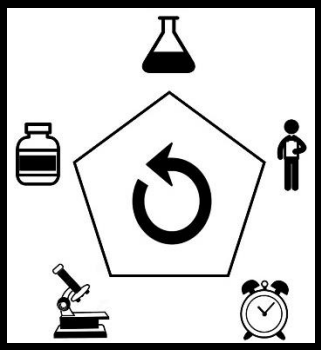
Green Chemistry: An upcoming generation of organic synthesis.

Much more than microwave or ultrasound based reactions.

Majority of the complex molecules can be synthesized in the lab, but with low efficiency and has drawn concern related to the chemical wastes that cause environmental effects. In this era of increased pollution there is a greater need for managing the chemistry used in various kinds of institutions and organisations. In a lay mans term the more eco friendly the reaction is better for the environment hence it is known as **Green Chemistry**, however it is not to be confused with the study of natural products. Various factors that play a major role in developing "Eco friendly" reaction are the chosen method, reagents, solvents, resource efficiency (personnel qualification), energy efficiency, product selectivity, operational simplicity, and health and environmental safety, time taken to complete the reaction, to evaluate the quality and quantity of a product. As shown in Figure 1

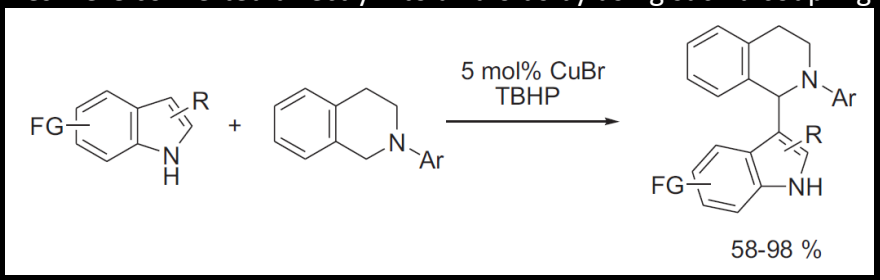


The successful reaction depends on methodology, resource efficiency, time taken, to evaluate the product and reagents used

To ensure and optimize the reactions certain guidelines were structured to follow green synthesis. Trost presented the term atom efficiency in the ''Twelve Principles of Green Chemistry'' and these rules have altered the way many chemists design and plan their syntheses.

From decades microwave reactions and ultrasound reactions are being used in green synthesis. Apart from these many innovative reactions have emerged in the recent times with many such advantages, with the help of chemical and biological catalysts, we shall see few of them.

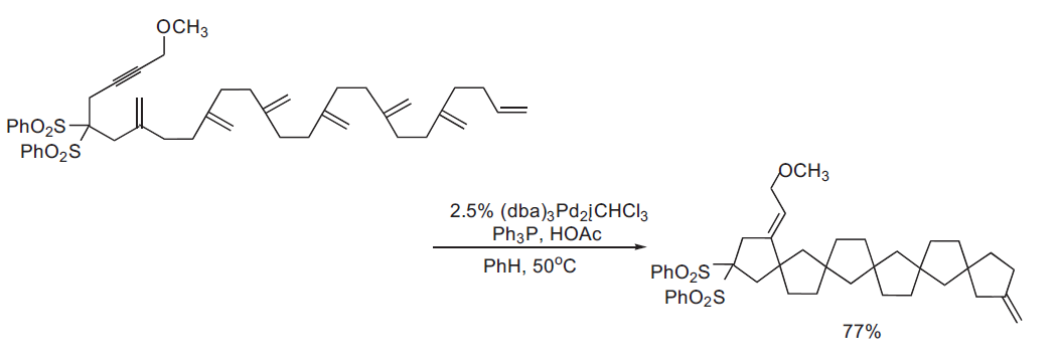
Direct Conversion of C–H Bonds Li et al and others have developed various methods to generate C–C bonds directly from two different C–H bonds in the presence of an oxidizing reagent through a cross-dehydrogenative coupling (CDC) catalyzed by transition metals. For example, (NH)- indoles and tetrahydroisoquinolines were converted directly into alkaloids by using such a coupling.



CDC reactions of various indoles with tetrahydroisoquinolines.

Organic synthesis extensively utilizes protection–deprotection of functional groups, which increases the number of steps in synthesizing the desired target compounds. Baran *et al.* have reported a total synthesis of a natural product without any protecting groups.

Tandem/Cascade/Flow Reactors. Also of fundamental importance to greener synthesis is the development of tandem and cascade reaction processes that incorporate as many reactions as possible to give the final product in one operation.



A palladium-catalyzed tandem reaction resulted in multi-rings in one step.

Solid state reactions are performed in the absence of solvents by either grinding or melting the starting materials together or simply applying heat to a mixture of starting materials. This type of reaction is usually performed in order to obtain polycrystalline inorganic solids but may also be used in organic synthesis. Bakthadoss et al have synthesized organic molecules via this tandem/domino effect seen in solid state melt reaction. Solid state reactions offer reduced costs, decreased amounts of chemical waste and, sometimes, an increase in yield.

Biocatalysis. Through millions of years of evolution and ‘‘sustainability,’’ nature developed highly efficient and selective means to achieve the desired transformations. Biocatalysis leads to extremely high reaction rates and selectivities such as enantioselectivities that go beyond the reach of chemical catalysts as discussed by Reetz M.T. and Jaeger K. E. These developments have provided powerful and parallel tools in the synthetic chemist’s toolbox. The recent exciting development by the Nobel prize winners Frances H. Arnold et al. in ‘‘directed evolution’’ provides potential opportunities in using biological catalysts to overcome this issue.

Conclusion

Our future challenges in resource, environmental, economical, and societal sustainability demand more efficient and benign scientific technologies for working with chemical processes and products. Green chemistry addresses such challenges by inventing novel reactions that can maximize the desired products and minimize by-products, designing new synthetic schemes that can simplify operations in chemical productions, and seeking greener solvents that are inherently environmentally and ecologically benign. Together, such fundamental innovations in chemical sciences will lead us to a new generation of chemical syntheses.

Vibha S
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SCIENTISTS

ROBERT BUNSEN

As a chemist, I bet that you certainly must have used or at least heard about the Bunsen burner. But did you know that there is a Bunsen Burner Day that commemorates the birth of its inventor? Well... Robert Wilhelm Eberhard von Bunsen was born on March 31, 1811, in Gottingen, Germany. He was only 17 when he started his undergraduate studies at the University of Gottingen, yet two years later he received his Ph.D. in chemistry for his work on a humidity meter. In 1832, Bunsen won a government scholarship that allowed him travel in Germany, France, Austria and Switzerland in order to study chemistry in different laboratories. He also made contact with well-known chemists such as Julius von Liebig and Louis Joseph Gay-Lussac. In 1833, he returned to Germany and began work, with no salary, as a lecturer at the University of Gottingen. He also pursued chemical research.

Discoveries and Inventions

1. Antidote for Arsenic Poisoning

At first, his research was mainly geared towards arsenic salts. He discovered that adding iron oxide hydrate to a
solution containing an arsenic compound yielded ferrous arsenate, which is insoluble and harmless. This discovery was an antidote to arsenic poisoning, the details of which he published in 1834.

2.Invention of the Zinc-Carbon Battery

In 1841 Bunsen invented the zinc-carbon or Bunsen cell. It replaced the expensive platinum electrode found in the earlier Grove cell with carbon in the form of pulverized coal and coke. The extraction of magnesium and other metals from their ores with electricity was now possible, once Bunsen had successfully joined these zinc-carbon cells into large batteries.

3. Science behind Geysers

In 1846, Bunsen was chosen to study volcanic activity in Iceland because of his knowledge of gas analysis. He descended into the volcano Hekla's crater and made important observations and tests. He found that that while water remained liquid underground despite temperatures above 100 C (212 F), it emerged at the earth's surface as boiling water or steam. He concluded that geysers were caused by a decrease in pressure as water moves from underground to the surface.

4. Bunsen Burner

It was during the process of developing spectroscopy that the Bunsen burner came into being. Bunsen realized that the spectral patterns observed were being contaminated by the light coming from the burner they were using to heat the elements. He modified the burner he was working with by mixing air into the gas before burning in order to obtain a high temperature, nonluminous flame.
Using the new burner, Bunsen and Kirchhoff were able to clearly see the spectra of all the chemicals they were studying.

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MARIE CURIE

The first woman Nobel Laureate Marie Curie was born in Warsaw, in Congress Poland in the Russian Empire, on 7th November 1867. She was the fifth and youngest child to her parents, who were well known teachers. She was a French physicist and chemist who conducted pioneering research on radioactivity. She was the first woman to win a Nobel Prize, the first person and only woman to win the Nobel Prize twice. She is the only person to win a Nobel Prize in two different scientific fields. She was part of the Curie family legacy of five Nobel prizes. She was also the first woman to become a professor at the University of Paris.

On both the paternal and maternal sides, the family had lost their property and fortunes. This condemned Marie and her elder siblings to a difficult struggle to get ahead in life. She has done much of her schooling under the guidance of her father. He brought much of the laboratory equipment home and instructed his children in its use. Her mother died of tuberculosis in May 1878, when she was 10 years old. After the tragedy she started attending the boarding school. She graduated on 12 June 1883 with a gold medal. Further, it was unable for her to enroll in a regular institution because she was a woman. Then she was allowed to pursue higher studies in an institution that admitted women students.

In 1895 Wilhelm Roentgen discovered the existence of X-rays, through the mechanism behind their production was not yet understood. In 1896, Henri Becquerel discovered that uranium salts emitted rays that resembled X-rays in their penetrating power. He demonstrated that this radiation, unlike phosphorescence, did not depend on external source of energy but seemed to arise spontaneously from uranium itself. Influenced by these two important discoveries, Curie decided to look into uranium rays as a possible field of research for a thesis.

She used an innovative technique to investigate the sample. Using this technique, her first result was the finding that the activity of the uranium compound depends only on the quantity of uranium present. Her studies included two Uranium minerals pitchblende and torbernite (also known as chalcolite). Her electrometer showed that pitchblende was four times as active as uranium itself and chalcolite twice as active. She concluded that it must contain another substance that was far more active than Uranium. In 1898, she discovered that the element Thorium was also radioactive. In July 1898, Curie and her husband published a joint paper announcing the existence of an element which they named “Polonium”. On 26th December 1898, the curies announced the existence of a second element, which they named “Radium”.

In December 1903 the Royal Swedish Academy of Sciences awarded Pierre Curie, Marie Curie and Henri Becquerel the Nobel Prize in Physics. In 1911, she received the Nobel Prize in Chemistry. On 4th July 1934 she died from aplastic anemia believed to have been caused from her long-term exposure to radiation. The physical and societal aspects of the Curie’s work contributed to shaping the world of the twentieth and twenty-first centuries. She remains a role model and an inspiration for Women in the scientific field.

Anna Mathew
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CHANDRASHEKHARA VENKATA RAMAN

He was an Indian physicist born in the former Madras Province in India, who carried ground breaking work in the field of light scattering. Young Raman was proficient in English and Science. Even in his young days, he wondered why the sea was blue and made up his mind to find the truth one day. As his family was not rich enough to send him for higher studies to England, he entered service in the Indian finance department. While he was working in Calcutta he heard of an association for the cultivation of science and obtained permission to carry on his experiment at the laboratory during his leisure hours.

On February 28th, 1928, Raman led an experiment with KS Krishnan, on the scattering of light when he discovered what now is called the 'Raman effect'. It was instantly clear that the discovery was of huge value. It gave further proof of the quantum nature of light. Raman was president of the 16th session of the Indian Science Congress in 1929. He was conferred a knighthood, and medals and honorary doctrates by various universities. He is the first Asian and non-white to receive and Nobel Prize in the sciences. Raman and Suri Bhagavantam discovered the quantum photon spin in 1932, which further confirmed the quantum nature of light.

Raman also worked on the acoustics of musical instruments. He worked out the theory of transverse vibration of bowed strings, on the basis of superposition velocities. He was also the first to investigate the harmonic nature of the sound of the Indian drums such as the tabla and mridangam. He also investigated the propagation of sound in whispering galleries. In 1948, Raman, through studying the spectroscopic behavior of crystals, approached in a new manner fundamental problems of crystal dynamics. He dealt with the structure and properties of diamond, the structure and optical behavior of numerous iridescent substances.

Throughout his life, he developed an extensive personal collection of stones, minerals and materials with interesting light scattering properties, which he obtained from his world travels as gifts. During his voyage to Europe, Raman noticed the blue colour of glaciers and the Mediterranean Sea. He was motivated to discover the reason for the navy blue colour. He employed monochromatic light from a mercury arc lamp which penetrated transparent material and was allowed to fall on a spectrograph to record its spectrum. He detected lines in the spectrum, which were later called 'Raman lines'. He presented his theory at a meeting of scientists in Bangalore on March 16th 1928, and won the Nobel Prize in Physics in 1930. India celebrates National Science Day on 28th February of every year to commemorate the discovery of the 'Raman Effect' in 1928.

At the end of October 1970, Raman collapsed in his laboratory, the valves of his heart had given away. He was moved to the hospital and doctors gave him four days to live. He survived and after a few days he refused to stay in the hospital as he preferred to die in the gardens of his institute surrounded by his followers. Raman died due to natural causes on November 21st, 1970.

LIPTHI DHARMAJA
1CBZ 1940553

POEMS

POETRIC FORM OF MY INTERNSHIP WORK

Indeed, Yes!
This social admirer of mine came to meet
me directly from Kasargor,
The Divine beings nation
He said Hello Bangalore! However, Bangalore
did not react on the grounds that its this
much far from the air terminal
Dark was his body,
Harsh was his surface- named as Mr.Pepper.
He came to me. Embraced me..
And with the aid of Ethanol:Water
spilled out his phytochemical sentiments
on me
which will help my Palladium rich heart
diminish to zero oxidation state..
Drop by drop his phytochemicals fell on
my little heart to get the ideal Palladium
Nanoparticles.
Because of the cultural contrast, the family
couldn’t accept us..
We tried passing the examinations of
general public like SEM, XRD, elemental
mapping
and so forth. The agglomeration of our
sentiments in
SEM and high Palladium rich love in XRD
couldn’t stop this relationship going!
The famous promises of Suzuki Coupling
and many more reactions were always kept.
And thus conquered another battle of love!

FEBINA PETER
1847423 4MCHE

A CHEMIST

Drip drop my chemicals
Every Milli I measure for that
precise,
I could get my results.
Pops and blasts were my expectations
With those color changes-to
prove.
To end my assumption with a
meaningful point.
Hypothesis is what people could
give.
Like an apple that bumped on
newton’s head.
Those downing salts dissolve
Till my saturation point.
That’s Where my precipitates
land.
My test tubes the sea - a ocean
of chemicals.
Poseidon the God of sea can alter
the water
But, it’s something like a chemistry
Who controls the phases not only
the water.

SANJAI B R
4BCB 1840722