Editorial

Our new network for centres with activities related to green chemistry, G2C2 continues to flourish. In the last couple of months we have welcomed new members from Singapore and Nigeria, and the network website has been formally launched. The legal status of G2C2 is being finalized to give it a good degree of independence in decision-making while benefitting from association with the GCN. We have also now confirmed that the 2015 annual meeting will be in Boston on August 20-21, immediately after the ACS meeting in the same city. We are currently finalizing the program in collaboration with our host Professor Wei Zhang at UMass and the first flyer can be seen in the newsletter. The event will also be co-organised with the ACS Green Chemistry Institute. As you will see, apart from the usual talks from members we will also have a session on Greening the Supply Chain. This seems especially appropriate given the strong related activity in the region notably the Green Chemistry and Commerce Council = GC3! We have already secured contributions from some exciting local speakers on this topic and also in another one of our priority areas – green chemistry education and outreach. Here the Beyond Benign Initiative is proving to be a flagship and we are delighted that Amy Cannon has agreed to talk.

G2C2 is not meant to be exclusive – a few keen individuals started it with common interests in sharing best practice between centres around the world. We charge only a small administration fee and only then to established centres. We have a number of enthusiastic individuals who have joined representing nascent centres – we hope to see some of those in Boston so they can make new contacts and learn from the existing centres what type of activities they can look forward to develop as their own centres develop. GCN’s support for G2C2 will continue to include a sponsored GCN Associate who would then help us to run the G2C2 event and its general activities over the next year. One exciting new development is the first G2C2 younger persons’ award. We received a fantastic field of applicants from around the world with the panel identifying at least 8 worthy winners. Unfortunately there can only be one winner and that person will be announced at the next International Symposium on Green Chemistry in La Rochelle in next month. The winner will receive all expenses to attend one of the next two G2C2 events. We are enormously grateful to our friends at ISGC for sponsoring this prize and we very much hope that it will encourage others to sponsor something similar in years to come.

GCN members may also be interested in attending a special one-day workshop on the valorization of food supply chain and other bio-wastes preceding the big EFIB exhibition and symposium series (www.efibforum.com) in Brussels on October 27. Please ask Katie Privett for more information about G2C2 or the Brussels workshop (Katie.privett@york.ac.uk).

Hope to see you in Boston and Brussels!

James Clark

York, April 2015
OECD Substitution and Alternatives Assessment Toolbox

The OECD Substitution and Alternatives Assessment Toolbox (SAAT) is a compilation of resources relevant to chemical substitution and alternatives assessments. Visit the four resource areas below to learn more about chemical substitution and alternatives assessments and get practical guidance on conducting them.

Learn about the current landscape of substitution and alternatives assessment practices in the: OECD Meta-Review of Current Practices

**Alternatives Assessment Tool Selector**
A filterable inventory of chemical hazard assessment tools and data sources to help you identify tools most relevant to your substitution and alternatives assessment goals. A listing of non-hazard assessment tools is also available. [Learn more]

**Alternatives Assessment Frameworks**
A summary of the current frameworks that can be used to assess alternatives. Guides and other resources for conducting a chemical substitution or alternatives assessment are included. [Learn more]

**Case Studies and Other Resources**
Links to case studies, toolkits, and product rating systems that provide examples, insights, and lessons learned on substitution and alternatives assessment approaches. [Learn more]

**Regulations and Restrictions**
A list of regulations and restrictions throughout OECD member countries that are driving the increased need for chemical substitution and alternatives assessment approaches. [Learn more]

From: [http://www.oecdsaatoolbox.org/Home/Index](http://www.oecdsaatoolbox.org/Home/Index)
Getting metals out of waste – *the bio-way*

We face a global resource crisis that goes well beyond the long-standing concerns about over-dependency on non-renewable carbon. We use increasing amounts of more and more elements to make a growing range of goods to satisfy the expanding desires of society. These elements are all sourced from this one planet and some are becoming scarce, yet we only embed about 10% of all the natural resources we consume (90% being wasted) and barely 10% of the enormous volume of electronics we use is recycled (the balance going into landfills and other waste streams). Clearly this is unsustainable and the immediate challenge is to recover valuable resources from waste. There are ways to do this and we need to develop the best and the most environmentally sound methods. In a recent review in Green Chemistry the use of bio-derived materials for recovering metal waste is discussed: many such materials have been shown to have value including algae (micro and macro), chitin/chitosan, plants, carbons and different types of biomass. The review provides a useful reference source for information and offers some insights in the way forward.

Read abstract

### Feedstocks | Process | Products
--- | --- | ---
All based on renewable resources | Mostly simple | Moving towards resource recovery

**Dodson et al., *Green Chem.*, 2015, 17, 1951-1965**
**DOI:** 10.1039/C4GC02483D

**Nitrogen to ammonia – *the easy way***

Nitrogen is one of our most abundant resources and with an outstanding set of green chemistry criteria to make it an ideal feedstock. Nature has learned to take advantage of this and nitrogen fixation is one of the most important life processes that occurs in microbial organisms that contain the enzyme nitrogenases. In what could be a breakthrough paper from Northwestern University, solid chalcogels containing FeMoS clusters not only convert nitrogen to the industrially vital ammonia, they do this at room temperature and pressure, and in water – only light is required for this remarkable example of catalysis.

Read abstract

### Feedstocks | Process | Products
--- | --- | ---
There are minor concerns over the future availability of Mo | Remarkably green process | No obvious concerns

**DOI:** 10.1021/ja512491v
A real alternative for making lactic acid

Lactic acid has become one of the flagship bio-platform molecules. Its most famous application is in making PLA but it can also be used to make a wide range of other useful substances including commodity and other chemicals. While lactic acid was manufactured from petroleum, the favoured route is now by fermentation of glucose though this route is not without its problems notably low space time yield. It is attractive to also consider chemocatalytic routes and one of the more appealing is using (crude) dihydroxyacetone obtained from glycerine from biodiesel production, and then using Lewis acid catalysis to convert the dihydroxyacetone to lactic acid. The relative merits of this route have been highlighted in an article from ETH in Switzerland. Tin-containing zeolites seem especially effective catalysts in the critical DHA to LA stage. LCA shows that this is a superior route compared to the biocatalytic route from glucose in terms of reduced energy demand and CO₂ emissions. Read abstract

Food emulsifiers from food waste

One of the major food wastes in southern Europe is olive waste. This is also an environmental blight causing serious pollution problems in several countries. Much effort has gone into getting value from olive wastes typically involving the recovery of (poly)phenolic wastes (which can be useful anti-oxidants) from the aqueous waste streams. To make more use of the wastes than the current practice of using as a solid fuel, we need to know more about their composition. In a new article from the Department of Food Technology in Thessaloniki, the macromolecular composition of aqueous waste streams is determined and they are tested as emulsifiers for foods. The results are promising and there seems to be a synergistic effect between large and small molecules in the wastes. Read abstract
Making metals stick using paper

Despite the apparent high recycling rates for waste paper, in reality much is of insufficient quality for reuse and is burned or sent to landfill. This provides an interesting opportunity to develop large scale waste valorization processes taking advantage of the relatively simple composition of most papers (compared for example, to woody biomass). In a new article from the Green Chemistry Centre at York, waste paper has successfully been converted to a powerful adhesive using microwave technology. The precise origin of the adhesion is not clear but an interesting analysis of the activity of different fractions suggests it is a complex effect arising from the synergistic effect of more than one component. Read abstract

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<thead>
<tr>
<th>Feedstocks</th>
<th>Process</th>
<th>Products</th>
</tr>
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<tbody>
<tr>
<td>Uses widely available low cost resource</td>
<td>Uses microwaves and large reactors are limited</td>
<td>Presumably the used adhesive will be biodegradable</td>
</tr>
</tbody>
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Zhang et al., *Green Chem.*, 2015, 17, 260-270 DOI: 10.1039/C4GC00768A

Greener Indicators

Analytical science has only received limited attention from green and sustainable chemistry compared for example, to synthetic chemistry. We need to look more carefully at the various auxiliaries that go into analytical processes. This includes solvents, stationary phases, and indicators among others. In an interesting article form Pauri in India, natural extracts are shown to be suitable as replacements for common indicators used in some acid-base titrations, notably phenolphthalein and methyl orange. Read abstract

<table>
<thead>
<tr>
<th>Feedstocks</th>
<th>Process</th>
<th>Products</th>
</tr>
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<tbody>
<tr>
<td>Natural resource but not clear how abundant it is</td>
<td>Quite simple solvent extraction process</td>
<td>Expect products to be safe and biodegradable</td>
</tr>
</tbody>
</table>

D. Singh et al., *Green & Sustainable Chemistry* DOI: 10.4236/gsc.2015.51001

*These are initial views and are by no means comprehensive. Thorough investigation would obviously be necessary to determine the true environmental impact at each of the stages in the lifecycle.*
GREEN CHEMISTRY IN THE NEWS – A QUARTERLY ROUND UP OF GC DEVELOPMENTS.

MEMBERS ARE ENCOURAGED TO SEND IN THEIR GC NEWS TO: info@greenchemistrynetwork.org

Study finds a natural impediment to the long-term sequestration of carbon dioxide

From: Phys.org

Credit: Christine Daniloff/MIT

Carbon sequestration promises to address greenhouse-gas emissions by capturing carbon dioxide from the atmosphere and injecting it deep below the Earth's surface, where it would permanently solidify into rock. The U.S. Environmental Protection Agency estimates that current carbon-sequestration technologies may eliminate up to 90 percent of carbon dioxide emissions from coal-fired power plants.

While such technologies may successfully remove greenhouse gases from the atmosphere, researchers in the Department of Earth, Atmospheric and Planetary Sciences at MIT have found that once injected into the ground, less carbon dioxide is converted to rock than previously imagined.

The team studied the chemical reactions between carbon dioxide and its surroundings once the gas is injected into the Earth—finding that as carbon dioxide works its way underground, only a small fraction of the gas turns to rock. The remainder of the gas stays in a more tenuous form.

"If it turns into rock, it's stable and will remain there permanently," says postdoc Yossi Cohen. "However, if it stays in its gaseous or liquid phase, it remains mobile and it can possibly return back to the atmosphere."

Read more: CO₂ sequestration

Nanoparticles for Clean Drinking Water

From: University of Twente

One way of removing harmful nitrate from drinking water is to catalyse its conversion to nitrogen. This process suffers from the drawback that it often produces ammonia. By using palladium nanoparticles as a catalyst, and by carefully controlling their size, this drawback can be eliminated. It was research conducted by Yingnan Zhao of the University of Twente’s MESA+ Institute for Nanotechnology that led to this discovery.

Due to the excessive use of fertilizers, our groundwater is contaminated with nitrates, which pose a problem if they enter the mains water supply. Levels have fallen significantly in recent years, as a result of various European directives. In addition, the Integrated Approach to Nitrogen programme was launched in various Dutch nature reserves at the start of January. Tackling the problem at source is one thing, but it will still be necessary to treat the mains water supply. While this can be achieved through biological conversion - bacteria convert the nitrate to nitrogen gas - this is a slow process. Using palladium to catalyse the conversion of nitrate to nitrogen speeds up the process enormously. However, this reaction suffers from the drawback that it produces a harmful by-product – ammonia.

Read more: Nanoparticles-for-clean-drinking-water
Plant plaster protects wine from vine decline

From: chemistryworld

A breathable and biodegradable adhesive patch to block fungal invasion of vine pruning wounds has been developed by nanotechnology scientists in the US. Symptoms of fungal disease esca, or vine decline, include reduced yields, stunted growth and even the sudden death of vines. Esca is prevalent throughout the world and poses a significant threat to the wine industry – some countries have lost 40% of their grape harvest to the fungus. Often whole collections of vines have to be removed and replaced. No fungicide treatment is available – sodium arsenite was previously used for control in Europe, but is now banned for health reasons. Pruning leaves vines particularly vulnerable. Cuts, an easy entrance for fungi, can be sealed with wax or tar, but this hinders healing and can contaminate the soil. The new patch developed by Alexander Yarin, of the University of Illinois, and coworkers contains a dense network of nanofibres and can be directly applied to the vine to physically prevent spores from entering a wound. ‘These fungi are 20–50µm in size and our nanofibre patches have a pore size of about 3–5µm, so the fungi are intercepted by this obstacle,’ explains Yarin.

The pores are too small for fungi spores to reach the wound but sufficient for the plant to breathe and heal

The nanofibres are made from a half-and-half blend of a biodegradable synthetic polymer and soy protein, an abundant waste product. Read more: soy waste valorisation

Switching desalination plants from carbon dioxide source to sink

From: chemistryworld

A UK researcher has proposed a new process to decompose waste desalination brine using solar energy that could allow desalination plants to act as a sink rather than a source of atmospheric carbon dioxide, and help to neutralise ocean acidity.

Approximately 30 billion m$^3$ of freshwater is produced by desalination each year, and this is predicted to double within the next decade to meet global demand. To combat the increased energy consumption and carbon dioxide emissions associated with this growth in capacity, research efforts have turned to employing renewable energy. In the system devised by Philip Davies at Aston University, magnesium chloride in waste brine is hydrolysed by energy generated by heliostat fields to magnesium oxide, which is discharged to the ocean. Due to its alkaline nature, this subsequently neutralises ocean acidity and gradually removes carbon dioxide through the conversion of magnesium oxide to bicarbonate, similar to ocean liming, with the advantage that the neutralising material is sourced from the seawater itself rather than mined. Hydrochloric acid produced as a byproduct could potentially be sequestered into silicate rocks. Read more: CO$_2$ sink
GREEN CHEMISTRY IN THE NEWS continued

Carbon nanoballs can greatly contribute to sustainable energy supply

From: Chalmers University of Technology

Researchers at Chalmers have discovered that the insulation plastic used in high-voltage cables can withstand a 26 per cent higher voltage if nanometer-sized carbon balls are added. This could result in enormous efficiency gains in the power grids of the future, which are needed to achieve a sustainable energy system. The renewable energy sources of tomorrow will often be found far away from the end user. Wind turbines, for example, are most effective when placed out at sea. Solar energy will have the greatest impact on the European energy system if focus is on transport of solar power from North Africa and Southern Europe to Northern Europe.

"Reducing energy losses during electric power transmission is one of the most important factors for the energy systems of the future," says Chalmers researcher Christian Müller. "The other two are development of renewable energy sources and technologies for energy storage."

An electrical tree, which is a major electrical breakdown mechanism of insulation plastic. Fullerenes prevent electrical trees from forming by capturing electrons that would otherwise destroy chemical bonds in the plastic.

Read more: Carbon-nanoballs-can-greatly-contribute-to-sustainable-energy-supply.aspx

Researchers Produce Two Biofuels from a Single Algae

From: Woods Hole Oceanographic Institution

A common algae commercially grown to make fish food holds promise as a source for both biodiesel and jet fuel, according to a new study published in the journal Energy & Fuels.

The researchers, led by Greg O’Neil of Western Washington University and Chris Reddy of Woods Hole Oceanographic Institution, exploited an unusual and untapped class of chemical compounds in the algae to synthesize two different fuel products, in parallel, from a single algae. "It’s novel," says O’Neil, the study’s lead author. "It’s far from a cost-competitive product at this stage, but it’s an interesting new strategy for making renewable fuel from algae."

Algae contain fatty acids that can be converted into fatty acid methyl esters, or FAMEs, the molecules in biodiesel. For their study, O’Neil, Reddy, and colleagues targeted a specific algal species called Isochrysis for two reasons: First, because growers have already demonstrated they can produce it in large batches to make fish food. Second, because it is among only a handful of algal species around the globe that produce fats called alkenones. These compounds are composed of long chains with 37 to 39 carbon atoms, which the researchers believed held potential as a fuel source.

www.algaeindustrymagazine.com

Read more: Two fuels from a single algae
Vehicle body made from cotton, hemp, and wood

From: Fraunhofer

Carbon and glass fibers reinforce synthetics so that they can be used for vehicle body construction. But in this regard, there is an abundance of potential found in natural fibers – obtained from hemp, cotton, or wood. If you combined bio-based textile and carbon fibers, you can obtain extremely light yet very sturdy components.

“Lightweight” is an important buzzword in automotive engineering, and just as important in the aerospace sector, too. Carmakers are increasingly counting on fiber reinforced synthetics. These fibers, which are embedded into the synthetic matrix, give the material its additional durability. Exactly which material you choose to use depends on its eventual application. Thus, primarily carbon fiber is used in Formula 1 racing. However, one drawback is its high price; even its processing can be tough. These are the reasons why carbon fiber-reinforced plastics (CFRPs) have still not yet found their path into wide-scale serial production so far to date. Glass fibers, on the other hand, are certainly reasonably priced, but heavy by comparison. But this may soon change, thanks to some new research approaches by researchers at the Application Center for Wood Fiber Research HOFZET of the Fraunhofer Institute for Wood Research, the Wilhelm-Klauditz-Institut WKI in Braunschweig. Read more: Vehicle body made from cotton, hemp and wood

‘Biobased’ still raising questions

From: Wageningen UR

Consumers often lack a full understanding of the term “bio based”. They often have lots of questions when they come across biobased products. This is the conclusion of a Wageningen UR study into people’s perceptions of biobased products across Europe. The study is part of the large-scale European research programme Open-Bio. Prior to conducting a quantitative survey, LEI Wageningen UR focus groups have been organized among 107 consumers in six European countries: Denmark, the Czech Republic, Slovenia, Italy, Germany and the Netherlands. According to Wageningen UR scientist Marieke Meeusen, there were very few differences between the perceptions of consumers in these countries. “We noticed that a large group of consumers did not quite know the term and they do not understand the concept”. They made associations with several items, among others biotechnology, organic farming or degradability. Others associated the term biobased primarily with the environment or, in an even broader sense, sustainability. The fact that biobased refers to products made from renewable raw materials seemed to be virtually unknown.” Read more: Biobased still raising questions
Thin film approach to biocatalysis

Taking an unconventional approach to biocatalysis has allowed scientists in Italy to improve enzyme recyclability with a solvent-free reaction mixture. And by emphasising a need to design processes, biocatalysts and reactors together, instead of separately, they hope to widen the industrial applications of nature’s catalysts.

Lucia Gardossi, from the University of Trieste in Italy, has been investigating solvent-free reaction mixtures, which appeal to industry because of their comparably small production volumes and lack of organic solvents to dispose of. Although their efficiency and selectivity are attractive, biocatalysed versions of industrial reactions are rarely economically viable. The typically viscous reaction mixtures require vigorous mixing, which damages the enzymes and limits their recyclability.

Gardossi’s team’s solution involves a thin film with enzymes covalently immobilised on resin carriers that they tested on a lipase-driven polyesterification. This system preserved the enzyme’s integrity, as the reaction mixture does not need to be stirred, improving recyclability. Read more: Biocatalysis solvent-free thin film

Running fuel cells on bacteria

Researchers in Trondheim have succeeded in getting bacteria to power a fuel cell. The “fuel” used is wastewater, and the products of the process are pure water droplets and electricity. “This is an environmentally-friendly process for the purification of water derived from industrial processes and suchlike”, says SINTEF researcher Luis Cesar Colmenares, who is running the project together with his colleague Roman Netzer. “It also generates small amounts of electricity – in practice enough to drive a small fan, a sensor or a light-emitting diode”, he says.

In the future, the researchers hope to scale up this energy generation to enable the same energy to be used to power the water purification process, which commonly consists of many stages, often involving mechanical and energy-demanding decontamination steps at its outset.

The biological fuel cell is powered by entirely natural processes – with the help of living microorganisms. “In simple terms, this type of fuel cell works because the bacteria consume the waste materials found in the water”, explains Colmenares. “As they eat, the bacteria produce electrons and protons. The voltage that arises between these particles generates energy that we can exploit. Since the waste in the wastewater (organic material) is consumed and thus removed, the water itself becomes purified”, he says. Read more: Running fuel cells on bacteria
GREEN CHEMISTRY IN THE NEWS continued

Engineered bacteria synthesise palladium biosorbent

From: chemistryworld

**Biomolecule–cellulose complexes could be used to recover precious metals**

Genetically modified Escherichia coli can synthesise a protein that could work as a palladium biosorbent to recover the precious metal from polluted water, new research shows.

Catalytic converters are hugely important for controlling car exhaust fumes but small amounts of the palladium, and other platinum group elements, that form their main active component are leaking into and contaminating the environment. ‘Global palladium resources are scarce,’ warns sustainability expert Magdalena Titirici, of Queen Mary University of London, UK, who was not involved in the study. ‘Therefore recovering noble metals such as palladium from the urban environment using low cost and environmentally friendly adsorbents is of major importance.’

Currently, palladium is extracted from the environment through methods that include acid precipitation, adsorption, ion exchange and electrolysis. However, these processes can be energy intensive and involve corrosive solutions that require proper chemical waste disposal. They are also neither selective nor efficient for low concentrations of palladium.

Now, Ian Yunus and Shen-Long Tsai from the National Taiwan University of Science and Technology have made a reusable adsorbent that is selective and efficient in recovering palladium without generating large volumes of hazardous waste.

Read more: [Palladium biosorbent](#)

New CMI process recycles valuable rare earth metals from old electronics

From: Ames Laboratory

Scientists at the Critical Materials Institute have developed a two-step recovery process that makes recycling rare-earth metals easier and more cost-effective.

Rare-earth metals are valuable ingredients in a variety of modern technologies and are found in cell phones, hard disk drives in computers, and other consumer electronics, which are frequently discarded for newer and more up-to-date versions.

According to the Environmental Protection Agency, U.S. consumers disposed of 3.4 million tons of electronics waste in 2012. Continuously increasing global demand for new consumer electronics in turn drives demand for rare-earth metals, which are difficult and costly to mine.

“Recycling rare-earth metals out of consumer waste is problematic, and there are multiple obstacles in the entire chain from manufacturing to collection infrastructure to sorting and processing,” said CMI scientist Ryan Ott. “We’re looking at ways to make the processing part of that chain—removing the rare-earths from scrap magnet material—better.”

Building upon previous research work done at the Ames Laboratory, Ott and his research group have developed a two-stage liquid metal extraction process that uses differences between the solubility properties of different elements to separate out rare-earth metals.

Read more: [Recycling valuable rare earths](#)
GREEN CHEMISTRY IN THE NEWS continued

Binding bad: Buckyballs offer environmental benefits

From: Rice University

Treated buckyballs not only remove valuable but potentially toxic metal particles from water and other liquids, but also reserve them for future use, according to scientists at Rice University.

The Rice lab of chemist Andrew Barron has discovered that carbon-60 fullerenes (aka buckyballs) that have gone through the chemical process known as hydroxylation aggregate into pearl-like strings as they bind to and separate metals – some better than others – from solutions. Potential uses of the process include the environmentally friendly removal of metals from acid mining drainage fluids, a waste product of the coal industry, as well as from fluids used for hydraulic fracturing in oil and gas production.

Barron said the treated buckyballs handled metals with different charges in unexpected ways, which may make it possible to pull specific metals from complex fluids while ignoring others.

The study led by Rice undergraduate Jessica Heimann appeared in the Royal Society of Chemistry journal Dalton Transactions. Read more: Buckyballs offer environmental benefits

Catalytic carbon dioxide convertors

From: chemistryworld

The world's demand for energy, and the resultant carbon dioxide emissions, are drastically changing our climate. UK startup Econic Technologies is developing catalysts that could take some of that CO₂ and lock it up in high-performance polymer materials.

Econic's catalysts allow carbon dioxide to react with a range of epoxides to make polycarbonate materials in which up to 50% of the polymer's molecular weight (depending on the epoxide structure) is derived from incorporated CO₂. The company spun off from Charlotte Williams' group at Imperial College London in 2011.

While Econic is not the only company developing ways to make such materials, its catalysts are some of the most active and selective available, claims commercial director Rulande Henderson. The product polymer chains contain precisely alternating carbonate and ring-opened epoxide groups, with no ether linkages from direct epoxide-epoxide coupling.

'So we can incorporate the maximum amount of carbon dioxide into the polymer,' Henderson adds. Read more: Econic profile

Moving forward on bio-based raw materials

From: edie.net

It doesn't take a genius to understand the advantages of getting the best raw materials at the best prices. One way to do that, and an increasingly important part of our procurement strategy, is to take advantage of industrial biotechnology. Biotech now presents some truly exciting opportunities as a source of raw materials and intermediates that may be cheaper, more sustainable, and offer advantages in terms of performance that were never imaginable with materials produced by more conventional 'straight chemical' technologies.

The exciting developments that offer such great promise in what most of us understand as biotechnology are the consequences of breakthroughs over the past half century that have allowed scientists to manipulate the most fundamental processes in living cells and organisms. And in white biotech, those breakthroughs mean, among other things, that microorganisms can serve as infinitesimally small factories that produce specific compounds of industrial value. Read more: Moving forward on bio-based raw materials
Plastic waste entering world’s oceans set to double in 10 years

From: chemistryworld

The amount of plastic waste entering the world’s oceans every year could be as much as 8 million tonnes – 3% of the plastic waste produced every year, according to new research findings released on 12 February at the American Association for the Advancement of Science’s annual meeting in San Jose, California.

The figure is one to three orders of magnitude higher than reports of the amount of floating plastic waste in the world’s seas. ‘That is the same as five bags filled with plastic for every foot of coastline in the world,’ says Jenna Jambeck, from the University of Georgia, US, and one of the authors of the study. ‘And it can get worse. If we assume a business as usual projection with growing populations, increasing plastic consumption and increased waste generation by 2025 this number doubles. We may be adding 17.5 million tonnes per year.’

For the past 40 years reports of plastic waste in the oceans have been commonplace. While some effort has been made to gather and look at the waste circulating in the world’s seas, no rigorous assessment has been made of how much plastic is making its way from the land into the sea. Jambeck says that this is because, until very recently, there was simply no interest. Added to this, assembling the right team of scientists with the appropriate skills was difficult.

Read more: Plastic waste entering oceans

Developments in the offshore seaweed feedstock bio-refinery model

From: Green Chemistry Blog

The land use issues associated with biomass production points to marine biomass as a promising alternative. Seaweed is a rich resource, abundant in the world’s oceans. In addition to its potential for biofuel production, it is also important to obtain a stream of renewable chemicals from any seaweed bio-refinery to create an economically viable and sustainable process.

The present development, led by an Indian research team prominent in this field, creates a valuable side stream of chemical products to supplement the production of bio-ethanol from cellulose. Lipids, pigments and agar are all obtainable from the red algae feedstock by way of sequential extraction processes that improves the quality of the agar produced and significantly reduces the amount of auxiliary chemicals required compared to previous methods.

Read more: Developments-in-the-offshore-seaweed-feedstock-bio-refinery-model
GREEN CHEMISTRY IN THE NEWS continued

The Biobattery

From: Fraunhofer

Sewage sludge, green waste, production residue from the food industry, straw or animal excrement – with the »biobattery’s« modular concept a much larger range of biomass can be utilized for energy recovery than previously. Researchers show that they can convert organic residues into electricity, heat, purified gas, engine oil and high quality biochar using this process.

Biogas plants are an important element for decentralized energy supply. They produce electricity from renewable resources and can compensate for highly fluctuating wind and solar energy. There are already 8,000 plants in operation in Germany with an electrical output of 3.75 gigawatts in total, that is the equivalent to roughly three nuclear power plants. However, the plants have several disadvantages too: they only process a limited range of organic substances and are in competition with the cultivation of food plants.

Scientists from the Fraunhofer Institute for Environmental, Energy and Safety Technology UMSICHT have now succeeded in considerably improving the efficiency of biogas plants. The biobattery process developed by them not only supplies electricity and heat but also high quality products such as gas, oil and vegetable carbon.

Read more: Pilot plant processes biogenous residues

Bioelectrochemical processes have the potential to one day replace petrochemistry

From: Helmholtz Centre for Environmental Research

Researchers at Helmholtz Center for Environmental Research (UFZ), Germany, and the University of Queensland (UQ), Australia, have found that the electrification of the white biotechnology is not merely a green dream, but an alternative to petrochemistry with realistic economical potential. Compared to classical sugar based bio-processes, bioelectrochemical processes promise improved yields, which could turn out to be a real game changer. The next generation of bio-production facilities may not only become more environmentally friendly, but also more economically competitive, a conclusion drawn jointly by scientists at UFZ and the UQ. In a recently published study in the scientific journal ChemSusChem, the researchers analysed for the first time the economical potential of this new technology using the example of an existing bio-process.

In contrast to the energy and fuel sectors that are influenced by government targets for green alternatives, the chemical industry is mainly driven by market mechanisms. Companies and consumers are generally not prepared to pay a green premium for products. This means that compared to classical petrochemical processes, bio-production of chemicals needs to be cheaper, or in case of comparable costs, offer added value for companies to take the risk of investment into a new production process.

Read more: Bioelectrochemical processes
Recycling of Rare Earth Elements from Energy Saving Lamps

From: RARE3 KU Leuven

KU Leuven Chemists have developed an innovative process, based on ionic liquid technology, for the recycling of the metals europium and yttrium from collected fluorescent and energy saving lamps. The metals are directly reusable in new lamps. Compared to traditional solvents, the ionic liquid has a multitude of advantages, including its selectivity for metal dissolution and its reusability.

For many modern electronic and cleantech applications rare-earth elements are indispensable. Although rare earths are not per se “rare”, they are difficult to mine and to purify. Furthermore, because the majority of the operational mines are located in China, the supply is subject to geopolitical tensions. Worldwide there is an increased interest to recycle rare earths from waste streams to mitigate the supply risk.

Two critical rare earths, europium and yttrium, are used in red lamp phosphor, a substance which transforms ultraviolet light into red light. This phosphor has been used for more than 40 years in the colour screens of televisions and in the tubes of fluorescent lamps. “Because it is very difficult to replace the red phosphor with a rare-earth free mixture, attention goes out the recyclability of the red phosphor fraction from fluorescent lamps. Although it is already obligatory to collect end-of-life fluorescent and energy saving lamps, the involved recycling is strongly focused on the safe removal of mercury from the waste. Because of the technical complexity to recuperate europium and yttrium using traditional solvents, the powder containing these two critical metals is typically not reused”, explains Professor Koen Binnemans. Read more: Recycling of rare earth elements

Integrating CO2 in the Value Chain: the Role of Chemistry

From: EuCheMS

This workshop, which took place on the 3 March 2015 at the European Economic and Social Committee in Brussels, explored the ecological and economic possibilities of integrating CO₂ in the value chain. Chaired by MEP Julie Girling and opened by Mindaugas Maciulevičius, from the European Economic and Social Committee, it counted with a presentation from EuCheMS President, Prof. David Cole Hamilton.

This event was an opportunity for participants to learn from the ESCA winners of 2014, Prof. Dr. Walter Leitner and Prof. Dr. Jürgen Klankermayer, who not only provided evidence on the rich possibilities of CO₂ conversion but also transmitted a clear message on sustainability: “If you want to go fast, go alone. If you want to go far, go together.” In addition the European Commission’s activities on these topics was delivered by José Lorenzo Valles from DG R&I.

The Workshop was co-organised with the European Parliament Intergroup on Climate Change, Biodiversity and Sustainable Development and brought together European policy-makers, the chemical sector, the academic world and civil society in order to discuss the opportunities of turning waste into fuels, basic chemicals, polymers, and even fine chemicals and pharmaceuticals.

To read all presentations and final report see: Integrating-co2-in-the-value-chain-the-role-of-chemistry

LAUNCH: Green Chemistry

Check out these videos from the LAUNCH: Green Chemistry Forum held on January 23 & 24, 2015 at NASA's Kennedy Space Center. LAUNCH Green Chemistry
**Company News**

**Mitsui Chemicals** announce the launch of STABIO™, a 70% bio-based polyisocyanate for use in paints and adhesives.

**Mitsui Chemicals** announced the successful development of "Do Green™", a bio-based high refractive index lens material using plant-derived material.

**Fermentalg** joins with Arkema and Soprema to launch Trans'Alg, a green chemistry collaborative programme to industrialize the production of substitutes for petroleum products destined for the chemical and fuel markets including jet fuel.

**Deinove** successfully completes the first key milestone of its Deinochem green chemistry program and receives 1 million euros from ADEME (French Environment and Energy Management Agency) in the framework of the French government initiative “Investing for the Future”

**Anellotech**, IFP Energies nouvelles and Axens have announced a strategic alliance to co-develop and commercialize a new technology for the low cost production of bio-based benzene, toluene and paraxylene using Anellotech’s process of Catalytic Fast Pyrolysis (CFP) of non-food biomass.

**Anellotech** and Johnson Matthey Process Technologies have announced an alliance to co-develop advanced catalyst systems for Anellotech’s Catalytic Fast Pyrolysis (CFP) Process for production of bio-based benzene, toluene and paraxylene for the chemical industry.

**Carlsberg** and partners to develop a biodegradable and biobased bottle made from sustainably sourced wood-fiber, to be known as the “Green Fiber Bottle”.

**Bayer Material Science** launch Imprani® eco, the first bio-based polyurethanes for textile coating.

**Amyris** enter the industrial cleaning products market with first products containing Myralene™ brand of renewable solvent.

**Evonik** demonstrate significantly more efficient copper extraction with hydrogen peroxide.

**Chemetall** Tech Cool® 35052CF, a Generation V high performance semi-synthetic metalworking coolant has received Boeing Aircraft approval for use under BAC5008. The “next generation” in coolant technology, Tech Cool 35052CF combines ultra-high lubricity characteristics required for aerospace alloys with green chemistry technologies.

**Global bioenergies** reports first isobutene production from waste biomass.

**Clariant** promotes its GlucoTain® sugar-based and sulfate-free surfactants range to the Personal Care industry.

**Jungbunzlauer** presents its range of CITROFOL® esters as safe and effective plasticizers with sound market growth as a bio-based alternative to traditional crude oil based products.

**Bio-on** S.p.A., a leader in eco-sustainable chemical technologies, and Pizzoli S.p.A., Italy’s largest operator in the potato sector, will collaborate to build Italy’s first PHAs bioplastic production plant using waste product from the potato agro-industrial process.

**GFBiochemicals** breakthrough levulinic acid technology now ready for commercialization. New patent for Floreon technology strengthens PLA bioplastics.

**Renmatix** and Total will utilize Renmatix’s proprietary Plantrose process with specific feedstocks to extract sugar for use in production of biobased products of interest to Total.

**BASF** has made bio-based Polytetrahydrofuran 1000 (PolyTHF® 1000) available for the first time. The company is now providing this intermediate to selected partners for testing various applications in a large scale.

**BASF** and eight partners cooperate to optimize production processes for renewable-based products with the launch of project PRODIAS (PROcessing Diluted Aqueous Systems).

**Sigma Aldrich**® Global Green Chemistry Initiative next phase kicked-off with special issue of Aldrichimica Acta.
Green Chemistry Jobs

- **EU MSCA FIRE (Fellows with Industrial Research Enhancement) Fellowships – PhD Fellowships: University of Bath UK** seek applications for ten 4-year PhD Fellowships. These are fully-funded staff appointments, with a requirement that successful candidates register for a PhD. Each position is associated with one of our two Centres for Doctoral Training:
  - Centre for Digital Entertainment (Department of Computer Science)
  - Centre for Sustainable Chemical Technologies

- **PostDoctoral Fellowship – Functional Bioaromatic Chemicals From Lignin: Scion (New Zealand) and VITO (Belgium)** The Postdoctoral fellow will undertake research work both in New Zealand and Belgium supported by expertise in lignin and biopolymer chemistry at Scion, and membrane engineering and chemical characterisation at VITO.

- **Postdoctoral Research Combining Sustainable Chemistry and Travel: University of Bath, UK** A twelve month fixed-term postdoctoral position is available, from 01 June 2015. This position forms part of the team working on a British Council funded *Global Innovation Initiative for TransAtlantic Discovery, Characterisation and Application of Enzymes for the Recycling of Polymers and Polymer Composites*.

- **Postdoctoral Scientist: GreenCentre Canada** 12-month contract position. Candidates should have interest in future employment in industry, specifically with early stage technology companies.

- **Postdoctoral Fellow/Research Scientist (Green Chemistry): Institute of Bioengineering and Nanotechnology, Singapore**. Research is focused on the development of green methodologies for chemical and pharmaceutical synthesis, CO2 utilization and biomass transformation.

- **R&D Chemist Liverpool ChiroChem**: Seeking a highly talented synthetic organic chemist with experience in the areas of asymmetric catalysis and/or total synthesis, who can implement and develop our specialist methods to enable production of novel products and carry out method development projects and technology transfer.

- **Opportunities for PhD candidates and Postdoctoral Fellows McGill University**: Focus on the design and development of new sustainable products which will both meet the needs of and stimulate the Canadian agricultural, forestry, fishing, mining, and energy sectors, while reducing the reliance on non-renewable resources. Initial expressions of interest should be emailed to Robin.Rogers@McGill.ca

- **EPSRC Fellowship in Sustainable Feedstocks (Early Career stage)**: A major theme for the Manufacturing the future is providing the feedstocks for next generation manufacturing processes, through transition of the state-of-the-art in the scale-up of physical sciences and biological outputs.

- **Research Chair in Sustainable Chemistry and Materials**: Department of Chemistry, Saint Mary’s University, Halifax, Canada. The successful candidate will be an emerging scholar who has demonstrated research productivity and potential to achieve international recognition within the next 5 – 10 years. The Selection Committee will begin considering applications immediately with an anticipated start date of January 1, 2016.

- **Future Earth Global Hub Directors**: Engage the world’s leading experts in sustainability and environmental research from a trans-disciplinary perspective, opportunities in Boulder (USA), Montreal (Canada), Paris (France), Stockholm (Sweden) and Tokyo (Japan)
Green Chemistry Events 2015

3rd International Symposium on Green Chemistry 3-7 May 2015, La Rochelle, France [event link]


2015 China International Biobased Technology and Partnering Conference 26-27 May 2015, Shanghai, China [event link]

11th International Conference on Renewable Resources & Biorefineries 3-5 June 2015, York, UK [event link]

2015 SusChem Stakeholder Event 8-9 June 2015, Brussels, Belgium [event link]

Biorefinery for Food, Fuels and Materials 2015 symposium 15-17 June 2015, Montpellier, France [event link]

BiobasedWorld at ACHEMA 2015 15-19 June 2015, Frankfurt am Main, Germany [event link]

BIO-TIC conference “From bugs to business: Unlocking the Bioeconomy in Europe” 23 June 2015, Brussels, Belgium [event link]

Understanding and Harnessing Bio-Catalysis for Biofuel 29 June – 1 July 2015, York, UK [event link]

CO₂ Recycling 1-2 July 2015, Düsseldorf, Germany [event link]

7th International Conference on Green and Sustainable Chemistry (GSC-7) and 4th JACI/GSC Symposium 5-8 July 2015, Tokyo, Japan [event link]

International Conference on Carbon Dioxide Utilization 5-9 July 2015, Singapore [event link]

Centre for Sustainable Chemical Technologies Summer Showcase 6-8 July 2015, Bath, UK [event link]

19th Annual green Chemistry & Engineering Conference 14-16 July 2015, N. Bethesda, USA [event link]

International Conference Sustainable Materials Science and Technology 15-17 July 2015, Paris, France [event link]

From Waste to Resources: Biomasses and Biorefineries for Food and Non-Food Productions 5 August 2015, Milan, Italy [event link]

International Conference for Young Chemists 5-7 August 2015, Penang, Malaysia [event link]

International Conference and Exhibition on Biopolymers and Bioplastics 10-12 August 2015, San Francisco, USA [event link]

Carbon Dioxide Utilisation 7-9 September 2015, Sheffield, UK [event link]

Sustainable Chemistry 2015 24-25 September 2015, Berlin, Germany [event link]

Green Chemistry and Sustainable Technologies 2015 30 September – 3 October 2015, Izmir, Turkey [event link]

European Forum for Industrial Biotechnology and the Bioeconomy 27-29 October 2015, Brussels, Belgium [event link]

10th European Bioplastics Conference 5-6 November 2015, Berlin, Germany [event link]

The Green Chemistry Network (GCN) aims to promote awareness and facilitate education, training and practice of Green Chemistry in industry, commerce, central, regional and local government, academia and schools. The network was initially launched in 1998 with funding from the Royal Society of Chemistry and is now funded on a project-by-project basis. The GCN is a not-for-profit Company Limited by Guarantee (Registered in England and Wales, No: 6879262).

The views expressed in this newsletter are not necessarily those of the Green Chemistry Network. Please read online to avoid unnecessary paper usage.