CHEMWATCH

Bulletin Board

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ASIA PACIFIC

Permit to label project

2024-02-08

The permit-to-label project was initiated to improve access to agricultural and veterinary (agvet) chemical products by migrating uses from current Australian Pesticides and Veterinary Medicines Authority (APVMA) permits to a registered product label. This initiative aims to provide greater certainty to industry through the registration of eligible use patterns, removing the need for industry to periodically apply to the APVMA for the renewal of permits.

Permit-to-label outcomes to date are listed below and the project has now been formally closed; however, applicants can still apply for 'permit-to-label uses' if the invitation remains relevant for your product.

Building on the success of this project, the APVMA is now exploring ways to incorporate the permit-to-label process into our core business in the future.

More information about the permit-to-label project and the invitation letters for use patterns registered through the project can be found on our website.

Permit-to-label outcomes

The use patterns in Table 1 have been registered through the APVMA permit-to-label project.

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Active	Concentration/s	Uses	Have any products transferred some or all of these uses on label*?
Azoxystrobin	200 g/L + 80 g/L cyproconazole 250 g/L 500 g/kg	Lettuce Olives Carrots *Rubus* (including raspberries, blackberries, boysenberries and loganberries) Pyrethrum crops Nursery stock Riberries, anise myrtle, lemon myrtle Non-food producing plants and vegetation	Yes
Dicamba	80 g/L + 340 g/L MCPA 500 g/L	Agricultural non-crop areas, commercial and industrial areas, pastures and rights of-way, pine plantations, rice (pre-sowing and post-sowing)	Yes
Glufosinate-ammonium	200 g/L	Blueberry Date palms, green tea and native foods Blackcurrant Green beans Duboisia Pyrethrum crops Nursery stock (non-food), foliage, cut flowers, wildflowers Tea tree Pitaya (Dragon fruit)	Yes
Tolclofos-methyl	500 g/L	Lettuce	Yes

Active	Concentration/s	Uses	Have any products transferred some or all of these uses on label*?
Amorphous silica	450 g/L	Tomatoes Mustard	Yes
Carbaryl	500 g/L	Mangoes	No
Tebufenpyrad	200 g/kg	Cucumbers	Yes
MCPA	250 g/L	Rhubarb	Yes
	750 g/L	Poppies Rice	Yes
Imazalil	750 g/kg	Mushrooms	No
Bupirimate	250 g/L	Cucurbits and peppers Eggplant Strawberries Nursery stock Cut flowers	Yes
Myclobutanil	400 g/kg	Cut flowers	Yes
Flupropanate	745 g/L	Oil tea tree Pasture and non-crop situations	Yes
Triadimenol	250 g/L 375 g/L	Parsnips Radish Swede Turnip Riberries Anise myrtle Lemon myrtle Non-food nursery stock Tea tree Chinese onion, leeks, shallots, spring onions, welsh onions	Yes
Propamocarb	600 and 605 g/L	Tomatoes (protected) Cut flowers Papaw or papaya (seedlings)	No
Atrazine	600 g/L 900 g/kg	Oil tea tree	Yes

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Active	Concentration/s	Uses	Have any products transferred some or all of these uses on label*?
Clofentezine	500 g/L	Citrus trees Almonds Tomatoes (protected)	Yes
Abamectin	18 g/L and 36 g/L	Snow peas and sugar snap peas Mushrooms Citrus trees Rhubarb Duboisia Raspberry, blackberry, blueberry and blackcurrant Papaya Cucumber, squash and zucchini Spring onions and shallots Sweet corn (field) Fruiting vegetables other than cucurbits (including tomatoes, peppers and eggplant) Lettuce Adzuki bean, mung bean and navy bean Tea tree Avocados Passionfruit Custard apple Lychees Nursery stock Cut flowers	Yes

Active	Concentration/s	Uses	Have any products transferred some or all of these uses on label*?
Amitraz	125 g/L 200 g/L 500 g/kg	Agricultural chemical products: Citrus trees Veterinary chemical products: Cattle tick in sheep, goats, deer and circus animals (state extension)	Yes
Fludioxonil	100 g/L 250 g/kg + 375 g/kg cyprodinil	Nursery stock and ornamentals Cut flowers Pyrethrum Lettuce Capsicum Alliums including bulb onions, spring onions, shallots and garlic Broccoli (seed) Pineapple (post-harvest) Chestnuts (post-harvest) Nursery stock and ornamentals Cut flowers Pyrethrum Lettuce Capsicum Alliums including bulb onions, spring onions, shallots and garlic Mustard Industrial hemp Spinach and silverbeet	Yes

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Active	Concentration/s	Uses	Have any products transferred some or all of these uses on label*?
Diflufenican	500 g/L	Pyrethrum crops Agricultural non-crop areas, commercial and industrial areas, grass pastures and rights-of-way Green peas	Yes
Metsulfuron-methyl	600 g/kg	Agricultural non-crop areas Mung beans	Yes
Tri-allate	500 g/L 750g/L 900 g/L	Mustard Oilseed poppies	Yes
Propyzamide	500 g/L 500 g/kg and 900 g/kg canola only	Chicory and endive Pyrethrum crops Mustard	Yes
Carfentrazone-ethyl	60 g/L, 240 g/L, 400 g/L and 400 g/kg	*Rubes* spp and *Ribes* spp sucker control	Yes
Carbendazim	500 g/L	Garlic	Yes
Simazine	500 g L	Almonds, hazelnuts and walnuts Cut flowers, foliage, wildflowers Ginger Leeks Nursery stock (non-food) Pyrethrum Tea tree	Yes

Active	Concentration/s	Uses	Have any products transferred some or all of these uses on label*?
Trifluralin	480 g/L 500, 530, 580 and 600 g/L	Duboisia Eggplant Herbs and spices Industrial hemp Mustard (oilseed) Parsnips Peppers (including capsicum, chillies and paprika) Quinoa Swedes and turnips Tea tree	Yes
Metolachlor and S-metolachlor	Metolachlor 720 g/L 960 g/L S-metolachlor 960 g/L	Mustard Spinach and silverbeet, spring onions and shallots, green beans and navy beans Adzuki bean and mung bean Oil tea tree Mustard Spinach and silverbeet, spring onions and shallots, green beans and navy beans Rhubarb Brassica leafy vegetables Culinary herbs	Yes
Oryzalin	125 g/L + 125 g/L trifluralin 500 g/L	Duboisia Ginger Mustard (oilseed)	Yes

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Active	Concentration/s	Uses	Have any products transferred some or all of these uses on label*?
Tebuconazole	210 g/L + 210 g/L prothioconazole 430 g/L 750 and 800 g/kg	Mustard Faba beans and broad beans Mung bean and soybean Duboisia Riberries Anise myrtle and lemon myrtle Tea tree Beetroot leaves, beetroot, chicory, endive, radish, silverbeet and spinach Carrots Walnuts Garlic Nursery stock Commercial forests and native vegetation	Yes
Cyazofamid	400 g/L	Poppy Nursery stock (non-food) Spinach and silverbeet Basil	Yes
Deltamethrin	5.5 g/L and 27.5 g/L	Mustard Tea tree oil Safflower	Yes
Quinoxyfen	250 g/L	Silverbeet Strawberry runner production	No

Active	Concentration/s	Uses	Have any products transferred some or all of these uses on label*?
Pirimicarb	500 and 800 g/kg	Mustard Strawberries Adzuki bean Mung bean Soybean Vetch Sweet potato Spring onion Blackberries	Yes
Beta-cyfluthrin	25 g/L	Turf Papaya or pawpaw Custard apple, lychee, mango, persimmon Tea tree	No
Fenhexamide	500 g/L	Peppers	Yes
2,4-D	300 g/L as the	Agricultural non-crop areas, commercial and industrial areas, pastures and rights of-way, fallow, hardwood and softwood plantations, duboisia, preparatory spray for fallow/ clear felled *Pinus elliottii* plantations prior to replanting pine seedlings, oil Tea Tree, Cavendish bananas	Yes
Ioxynil	250 g/L 500 g/L	*Tanacetum*	Yes
Metham	423 g/L	Blueberries and *Rubus* spp. berries	Yes

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Active	Concentration/s	Uses	Have any products transferred some or all of these uses on label*?
Linuron	450, 480 or 500 g/L or 500 or 800 g/kg	Pyrethrum Celeriac Onions Celery Oil Tea Tree Parsnips Jojoba	Yes
Metiram	550 g/kg 700 g/kg	Apples, nursery stock	Yes
Fluazifop-P	128 g/L 212 g/L 212 g/kg	Ginger Mustard Olives Brassica leafy vegetables Chicory Coriander Endive Parsley Radicchio Silverbeet Spinach Swede Turnip Industrial hemp	Yes
Thiabendazole	200 g/L + 360 g/L thiram 500 g/L	Peanuts Sweet potato	Yes
Esfenvalerate	50 g/L	Oilseed poppies Mustard Olives Celery	Yes
Flonicamid	500 g/L	Tomatoes Strawberries Nursery stock	No

Active	Concentration/s	Uses	Have any products transferred some or all of these uses on label*?
Pendimethalin	330 g/L 435–475 g/L	Hops Spring onions Shallots and radish Brassica leafy vegetables and rocket Soybean Brussels sprouts Parsnip Leeks Industrial hemp Peas Garlic Adzuki bean	Yes
Permethrin	100 g/L 500 g/L	Pine logs Mustard Rhubarb Celery	No

Table 1: Use patterns registered through the permit-to-label project

* During the invitation period.

Read More

APVMA, 08-02-24

https://www.apvma.gov.au/registrations-and-permits/chemical-product-registration/permit-to-label-project

China Unveils New Regulations on Dangerous Goods Transport by Air

2024-02-06

This regulation is revised to ensure safe, well-regulated and efficient transport of dangerous goods by air.

On February 4, 2024, the Chinese Ministry of Transport (MOT) made public the revised Regulation on Administration of Transport of Dangerous Goods by Air (CCAR-276-R2). It is set to take effect on 1 July 2024 and replace the 2016 version (CCAR-276-R1).

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The revised Regulation slashes licensing requirements by further reducing materials required in the application for the license of transport of dangerous goods and simplifies the categories of licensing for airlines from Hong Kong, Macao, Taiwan, and foreign countries, aiming at differentiated and precise supervision. It prompts enterprises to assume the primary responsibility for the transport safety of dangerous goods. For example, it fleshes out the requirements concerning the handling of dangerous goods for shippers and shipper's agents, ground service agents, airlines as well as relevant training agencies.

Another key focus is enhancing the emergency response capabilities of stakeholders. As per the revised Regulation, shippers and shipper's agents must provide accurate emergency response measures when shipping dangerous goods. Airlines and ground service agents should incorporate contingency plans and exercise requirements for emergencies related to the transportation of dangerous goods into their transport handbooks. Furthermore, airport authorities are responsible for developing and overseeing contingency plans for the transportation of dangerous goods within airports. As the Safety Management System (SMS) is steadily advancing within the aviation industry, new management philosophies and ideas are incorporated into the revised Regulation. Airlines and ground service agents will be required to establish and operate the SMS for air transport of dangerous goods.

Read More

Chemlinked, 06-02-24

https://chemical.chemlinked.com/news/chemical-news/china-unveils-new-regulations-on-dangerous-goods-transport-by-air

Japan to Ban PFOA Isomers, Their Salts and PFOA-related Compounds

2024-02-01

Japan will prohibit the manufacture, import and use of PFOA isomers, their salts and PFOA-related compounds, and prohibit the import of certain products in which these substances are used.

On February 1, 2024, the Japanese Ministry of Health, Labour and Welfare (MHLW), Ministry of Economy, Trade and Industry (METI), and Ministry of Environment (MoE) issued a joint consultation regarding the designation of PFOA isomers, their salts and PFOA-related compounds as Class I

Specified Chemical Substances controlled under the Chemical Substance Control Law (CSCL).

Read More

Chemlinked, 01-02-24

https://chemical.chemlinked.com/news/chemical-news/japan-to-ban-pfoa-isomers-their-salts-and-pfoa-related-compounds

AMERICA

An environmental justice analysis of air pollution emissions in the United States from 1970 to 2010

2024-01-15

Over the last decades, air pollution emissions have decreased substantially; however, inequities in air pollution persist. We evaluate county-level racial/ethnic and socioeconomic disparities in emissions changes from six air pollution source sectors (industry [SO2], energy [SO2, NOx], agriculture [NH3], commercial [NOx], residential [particulate organic carbon], and on-road transportation [NOx]) in the contiguous United States during the 40 years following the Clean Air Act (CAA) enactment (1970-2010). We calculate relative emission changes and examine the differential changes given county demographics using hierarchical nested models. The results show racial/ethnic disparities, particularly in the industry and energy generation source sectors. We also find that median family income is a driver of variation in relative emissions changes in all sectors—counties with median family income >$75 K vs. less generally experience larger relative declines in industry, energy, transportation, residential, and commercial-related emissions. Emissions from most air pollution source sectors have, on a national level, decreased following the United States CAA. In this work, we show that the relative reductions in emissions varied across racial/ethnic and socioeconomic groups.

Introduction

The United States (US) has seen reductions in air pollution emissions from various source sectors since the enactment of the Clean Air Act (CAA) in 1970, contributing to improving air quality substantially1,2,3. However, studies show that racial/ethnic and socioeconomic inequities in air pollution exposure persist across the US despite the nationwide

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downward trend in air pollution4,5,6,7, indicating inequities in air pollution emissions reductions.

Environmental justice studies in air pollution have heavily relied on modeled ambient air pollution concentrations4,5,6,8,9,10. Unlike measured air pollutant concentrations, modeled concentrations can more comprehensively cover geographical regions, including those where air quality monitors are sparse11. However, pollution concentrations alone do not provide information about specific air pollution sources contributing to the observed disparities. A couple of studies have addressed this knowledge gap by modeling source-specific air pollution concentrations7,12. The disconnect between the studied air pollution concentrations and air pollution sources presents a barrier to developing efficient and economically feasible regulatory strategies to address air pollution inequities. Equitable emissions decrease, i.e., greater reductions for overburdened groups, can then facilitate a more just reduction of air pollution concentrations and exposures.

Read More

Nature, 15-01-24

https://www.nature.com/articles/s41467-023-43492-9

Federal agency sizing up air pollution from bagel shops and pizzerias

2024-01-17

As Montreal area politicians stall on the issue, a federally-run agency is considering forcing wood-burning businesses to report emissions.

The federal environment ministry is looking into whether some restaurants and bakeries that cook food in wood-fired ovens should be reporting their total air pollution emissions to the National Pollutant Release Inventory each year.

The NPRI is a federally legislated, publicly accessible inventory of pollutants that industrial, commercial and institutional facilities release into air, water and on land. All owners and operators of facilities that meet certain requirements must send annual reports detailing their facilities' total pollution releases each year to the NPRI, which reports to the minister of environment and climate change.

"The NPRI program has recently undertaken compliance promotion activities targeting some wood-fired ovens such as pizzerias and bagel

shops across Canada, including Montreal," Cecelia Parsons, a spokesperson for Environment and Climate Change Canada (ECCC), told The Gazette in a written statement.

There are about 100 commercial outlets on the island of Montreal that still cook food — bagels, pizza, grilled chicken, for example — in wood-fired ovens or over charcoal grills. Public health authorities have been sounding the alarm for years on this issue as evidence builds that the fine particulate pollution in wood smoke puts the health, and in some cases, the lives, of those who live near these establishments at risk.

Parsons said the federal program has begun "compliance promotion" work as "a first step, as part of a scoping exercise to determine if those facilities meet the NPRI reporting thresholds."

Read More

The Gazette, 17-01-24

https://montrealgazette.com/news/local-news/federal-agency-sizing-up-air-pollution-from-bagel-shops-and-pizzerias

EPA Tightens Air Quality Limits for Particulate Matter Pollution

2024-02-08

States will need to tighten up their compliance with soot limits under a new rule finalized by the EPA on Wednesday.

The Environmental Protection Agency decreased the amount of allowable particulate matter, or PM 2.5, permitted in the ambient air. Under the final rule, the EPA tightened the allowable threshold from 12 to 9 micrograms per cubic meter daily, the first change in the limits since 2012.

This "action is a critical step forward that will better protect workers, families and communities from the dangerous and costly impacts of fine particle pollution," EPA administrator Michael Regan told press on Tuesday. "The science is clear, soot pollution is one of the most dangerous forms of air pollution and it's linked to a range of serious and potentially deadly illnesses."

Particulate matter is one of six harmful pollutants that administrations regulate through National Ambient Air Quality Standards. States submit plans for approval for each of the limits, which are supposed to be regularly reviewed and updated to protect public health.

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Environmental and health groups hailed the finalized limits, which they say is a crucial update for a pollutant that is getting worse with global warming impacts.

"This will help save lives today and improve the health of generations to come," Natural Resources Defense Council president Manish Bapna said in a statement. "Soot puts tens of millions of Americans at risk, disproportionately harming low-income communities and people of color."

Exposure to PM 2.5 can result in a gamut of adverse health effects, from short-term lung distress to heart disease. The EPA estimates $46 billion in net health benefits in 2032 stemming from the new rules.

Increased wildfires made worse by climate change spread PM 2.5 across the US every year, which advocates say necessitates stricter standards—while industry argues the opposite.

Largely GOP-led states and industry trade groups will likely wage legal war over the standards, which they have fought hard to quash in public commentary, reports, and even national television ads. Critics say stricter limits in addition to uncontrollable fires will push big chunks of the country out of clean air law attainment.

"The EPA's decision to significantly lower the current standards will have wide ranging negative implications well beyond the mining industry -- impeding permitting for factories, energy and infrastructure projects," according to a statement from Rich Nolan, president of the National Mining Association.

Read More

Bloomberg Law, 08-02-24

https://news.bloomberglaw.com/environment-and-energy/epa-tightens-air-quality-limits-for-particulate-matter-pollution

EUROPE

All WASHED UP - What are the risks for firms that won't show greenwashing the red card?

2024-01-18

In recent years, there has been a noticeable increase in green products and the promotion of sustainable objectives across the financial services

industry. For example, we have seen much discussion of green loans, green bonds, sustainable funds and the appointment of Heads of Sustainability or of ESG at many banks and investment managers in the UK and Europe.

But what has been driving this, and now more importantly, what are the risks for firms that go down this route?

The pressure on banks and other financial institutions to assume responsibility for environmental issues has grown considerably. But addressing the fight against global warming should not simply be seen as a burden – it can also be an opportunity.

What are the risks for firms that seek to publicise sustainable objectives?

In our view, one of the key risks is a direct result of one of the many forces that are driving increased visibility of these issues – regulation. Firms that operate in multiple jurisdictions or across multiple sub-sectors of the financial services industry are subject to ever more regulation which is being applied on different timetables and with different geographical reach. Many of the measures also include moving targets – for example, many asset managers and owners operating in Europe will have rushed to make their initial disclosures under the Sustainable Finance Disclosure Regulation (SFDR) in 2021, but then found they needed to make further changes once they started disclosing under the Level 2 rules from June 2023.

Firms that operate in multiple jurisdictions or across multiple subsectors of the financial services industry are subject to ever more regulation

This can lead to a greater risk for firms of accusations of greenwashing, arising from intentional action (firms making inaccurate statements or promises they cannot keep) or unintentional action (where they fail to meet particular disclosure requirements, or only comply with some but not all).

Where do these overlapping requirements come from?

We highlight below a few examples of regulations covering ESG disclosures to show how a firm with cross-border operations can find itself subject to multiple layers of regulation, sometimes seeking to achieve different aims or cover different activities. The aim of many of these regimes is to avoid 'greenwashing' practices that mislead investors

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about the real contribution of issuers and products to meeting green commitments.

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ACC, 18-01-24

https://www.lexology.com/library/detail.aspx?g=b04c9165-2263-4d41-ae99-2170f21f0d57

Symbol of polarisation': EU scraps plans to halve use of pesticides

2024-02-07

The European Commission is shelving plans to cut pesticide use and is taking the pressure off agriculture in its latest emissions recommendations, as farmers around Europe continue protests demanding higher prices for their products and an easing of EU environment rules.

The original proposal to halve chemical pesticide use in the EU by the end of the decade – part of the EU's green transition – "has become a symbol of polarisation", said the commission president, Ursula von der Leyen. She added that she would ask the commission to withdraw the proposal.

Separately on Tuesday, the commission recommended that the EU slash net greenhouse gas emissions by 90% by 2040 but without the stipulation from previous drafts that farming would need to cut non-CO2 emissions by 30% from 2015 levels in order to comply.

The moves mark the bloc's latest environmental concessions to farmers, whose recent protests across Europe in countries including France, Germany, Belgium, the Netherlands, Poland and Greece spread this week to Spain and Italy.

Last week, in response to the protests, the bloc announced plans to limit market disruption from Ukrainian products entering the EU and delayed rules on setting aside more land to promote soil health and encourage biodiversity.

Protests continued to spread on Tuesday. In Spain, thousands of farmers used WhatsApp groups to stage a series of informal protests, blocking off major roads around the country. Among the signs displayed by the tractors was one that read: "Our end will mean your hunger!"

Demonstrations cut off roads in the regions of Madrid, Catalonia, Andalucía, Valencia, La Rioja, Castilla-La Mancha and Castilla y León. They also blockaded the port of Málaga and obstructed access to a massive wholesale market in Valladolid.

Greek farmers also said on Tuesday they would block motorways and converge on Athens in their tractors after dozens of farmers' federations voted to take concerted action at a meeting in the central city of Larissa, the state news agency ANA said.

In Italy, farmers from argricultural regions protesting about red tape and cheap non-EU imports have begun converging on Rome, with tractors sporting the Italian flag and banners with slogans such as "No farmer, no food."

Read More

The Guardian, 07-02-24

https://www.theguardian.com/environment/2024/feb/06/symbol-of-polarisation-eu-scraps-plans-to-halve-use-of-pesticides

Commission welcomes political agreement to make clean technology manufacturing in the EU resilient and competitive

2024-02-06

The Commission welcomes the provisional political agreement reached today between the European Parliament and the Council on the Net-Zero Industry Act (NZIA). This agreement will help the EU become home to clean technologies and make significant strides towards building a strong domestic manufacturing capacity of those technologies in the EU. NZIA will enhance the competitiveness and resilience of the European industry and support the creation of green, quality jobs as the EU seeks to reach climate neutrality by 2050.

Ursula von der Leyen, President of the European Commission, said: "The political agreement on the Net-Zero Industry Act is a significant stride towards realising our ambitious climate and economic objectives. It demonstrates our collective commitment to build a more sustainable, resilient and competitive industrial sector in Europe. Together, we are making the EU a global frontrunner in the clean energy transition."

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As a central part of the Green Deal Industrial Plan, the Act will ensure the EU is well-equipped for the clean energy transition by establishing a benchmark for EU manufacturing capacity for net-zero technologies to reach at least 40% of expected EU demand by 2030. The agreed Act will create the favourable regulatory conditions necessary to attract and support investment in technologies and related projects that will make a significant contribution to decarbonisation. The agreed provisions will in particular help build more production facilities of net-zero technologies, in a faster manner. It will facilitate access to markets for products that meet European sustainability and resilience criteria and that help to diversify from over-concentrated supply sources. It will also ensure that the necessary skilled workforce is available to support the race to net-zero.

More specifically, the provisionally agreed regulation identifies a broad set of net-zero technologies that can be supported via strategic projects. These are for example solar photovoltaic (PV), onshore and offshore wind, fuel cells, electrolysers, batteries, grid technologies and sustainable alternative fuels, among others. Following the provisional deal reached today, energy intensive industries such as steel, chemicals or cement that produce components that are used in these net-zero technologies and that invest in decarbonisation can also be supported as strategic projects.

Boosting net-zero manufacturing investments and projects

Today's agreement will also allow to:

- Create a simplified and enabling regulatory environment for clean tech: The agreed Act will reduce administrative burden and simplifies permitting for net zero technologies. For Net-Zero Strategic Projects it speeds up permitting even more. The deal reached today introduces the concept of Net-Zero Acceleration Valleys, which can be set up by Member States to facilitate the creation of clusters of net-zero industrial activity and further streamline administrative procedures. Environmental assessments of the geographic area under applicable legislation will help to streamline subsequent planning for individual projects.
  Accelerate CO2 capture and storage in the EU: The provisional agreement sets an EU objective to reach an annual 50 million tonnes of injection capacity in geological CO2 storage sites in the EU by 2030. These Net-Zero Strategic CO2 Storage Projects will be realised with contributions from EU oil and gas producers based on their pro-rata production. In line with the aims of the Industrial Carbon Management Communication published today, the agreement removes a major

barrier to developing CO2 capture and storage as an economically viable climate solution, in particular for hard-to-abate emissions in energy-intensive industries.
Facilitate market access for net-zero products: The compromise reached requires public authorities to consider sustainability and resilience criteria for certain net-zero technologies in procurement processes as well as in auctions for the deployment of renewable energy. For public procurement procedures, at least one additional criterion among social sustainability, cyber security and an obligation to deliver on time has to be used. When it comes to auctions for the deployment of renewables, the deal sets mandatory non-price criteria, namely the auction's sustainability and resilience contribution, cybersecurity, responsible business conduct, and ability to deliver projects fully and on time. These criteria will have to apply to least 30% of the volume, or 6 gigawatts, auctioned every year by a Member State.
Support the development of net-zero skills and innovation: Net-Zero Industry Academies will be established to support the upskilling of workers needed for the scaling up of net-zero industries in the EU and to facilitate their mobility within the European single market.
The agreed Act also includes incentives for industry to invest in the education and training of Europe's workforce. To foster innovation, the new rules will empower Member States to create regulatory sandboxes for testing innovative net-zero technologies under flexible conditions.

Finally, the Act foresees the creation of a Net-Zero Europe Platform to serve as a central coordination hub, fostering information exchange to facilitate the implementation and supporting investment initiatives throughout the EU.

Read More

European Commission, 06-02-24

https://ec.europa.eu/commission/presscorner/detail/en/IP_24_680

Commission publishes its Annual Union Work Programme on European Standardisation for 2024

2024-02-02

Today the Commission published its Annual Union Work Programme on European Standardisation (AUWP) 2024, which sets out its priorities on all activities related to standards. The AUWP was informed and advised by the High-Level Forum on European

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standardisation, a multi-stakeholder group chaired by Commissioner Thierry Breton.

The 2024 AUWP includes 72 actions supporting the EU's policy ambitions towards a green, digital and resilient Single Market. Amongst these, the Commission highlights eight particular actions as policy priorities, including standards for activities on quantum, critical raw materials, the data economy, digital identity, heat pumps, cybersecurity, hydrogen and electric vehicles charging infrastructure.

Today also marks the second anniversary of the Commission's standardisation strategy, aimed at strengthening the EU's global competitiveness, enabling a resilient, green and digital economy.

Commissioner Thierry Breton, in charge of the Single Market, said: "Today, on the second anniversary of the Commission's Standardisation Strategy, we are publishing an ambitious new annual work programme on standardisation. This will reinforce our role as a global standard-setter in strategic areas, from raw materials to quantum. These standards will be essential for Europe's competitiveness and economic security."

More information

- Annual Union Work Programme on European Standardisation
- High-Level Forum on European standardisation

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European Commission, 02-02-24

https://single-market-economy.ec.europa.eu/news/commission-publishes-its-annual-union-work-programme-european-standardisation-2024-2024-02-02_en

Commission presents recommendation for 2040 emissions reduction target to set the path to climate neutrality in 2050

2024-02-06

The Commission has today published a detailed impact assessment on possible pathways to reach the agreed goal of making the European Union climate neutral by 2050. Based on this impact assessment, the Commission recommends a 90% net greenhouse gas emissions reduction by 2040 compared to 1990 levels, launching a discussion with all stakeholders; a legislative proposal will be made by the next

Commission, after the European elections, and agreed with the European Parliament and Member States as required under the EU Climate Law. This recommendation is in line with the advice of the European Scientific Advisory Board on Climate Change (ESABCC) and the EU's commitments under the Paris Agreement.

Today's communication also sets out a number of enabling policy conditions which are necessary to achieve the 90% target. They include the full implementation of the agreed 2030 framework, ensuring the competitiveness of the European industry, a greater focus on a just transition that leaves no one behind, a level playing field with international partners, and a strategic dialogue on the post-2030 framework, including with industry and the agricultural sector. The outcome of COP28 in Dubai shows that the rest of the world is moving in the same direction. The EU has been leading the way on international climate action, and should stay the course, creating opportunities for European industry to thrive in new global markets for clean technology.

Predictability and sustainability for our economy and society

Setting a 2040 climate target will help European industry, investors, citizens and governments to make decisions in this decade that will keep the EU on track to meet its climate neutrality objective in 2050. It will send important signals on how to invest and plan effectively for the longer term, minimising the risks of stranded assets. With this forward-planning, it is possible to shape a prosperous, competitive and fair society, to decarbonise EU industry and energy systems, and to ensure that Europe is a prime destination for investment, with stable future-proof jobs.

It will also boost Europe's resilience against future crises, and notably strengthen the EU's energy independence from fossil fuel imports, which accounted for over 4% of GDP in 2022 as we faced the consequences of Russia's war of aggression against Ukraine. The costs and human impacts of climate change are increasingly large, and visible. In the last five years alone, climate-related economic damage in Europe is estimated at €170 billion euros. The Commission's impact assessment finds that, even by conservative estimates, higher global warming as a result of inaction could lower the EU's GDP by about 7% by the end of the century.

Establishing the conditions for achieving the recommended target

Achieving a 90% emissions reduction by 2040 will require a number of enabling conditions to be met. The starting point is the full implementation of the existing legislation to reduce emissions by at

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least 55% by 2030. The ongoing update of the draft National Energy and Climate Plans (NECPs) is a key element in monitoring progress and the Commission is engaging with Member States, industry and social partners to facilitate the necessary action.

The Green Deal now needs to become an industrial decarbonisation deal that builds on existing industrial strengths, like wind power, hydropower, and electrolysers, and continues to increase domestic manufacturing capacity in growth sectors like batteries, electric vehicles, heat pumps, solar PV, CCU/CCS, biogas and biomethane, and the circular economy. Carbon pricing and access to finance are also critical for the delivery of emission reduction targets by European industry. The Commission will set up a dedicated taskforce to develop a global approach to carbon pricing and carbon markets. Europe will also need to mobilise the right mix of private and public sector investment to make our economy both sustainable and competitive. A European approach on finance will be needed in the coming years, in close cooperation with Member States.

Fairness, solidarity and social policies need to remain at the core of the transition. Climate action has to bring benefits to everybody in our societies, and climate policies need to take into account those who are most vulnerable, or face the greatest challenges to adapt. The Social Climate Fund and Just Transition Fund are examples of such policies which will already help citizens, regions, businesses and workers in this decade.

Finally, open dialogue with all stakeholders is a crucial precondition to delivering the clean transition. The Commission has already established formal dialogues with industry and agricultural stakeholders, and the coming months of political debate in Europe are an important opportunity to secure public engagement on the next steps and policy choices. Structured dialogue with social partners should be strengthened to ensure their contribution, focusing on employment, mobility, job quality, investments in reskilling and upskilling. This ongoing outreach will help the next Commission to table legislative proposals for the post-2030 policy framework which will deliver the 2040 target in a fair and cost-efficient manner. The pace of decarbonisation will depend on the availability of technologies that deliver carbon-free solutions, and also on an efficient use of resources in a circular economy.

The energy sector is projected to achieve full decarbonisation shortly after 2040, based on all zero and low carbon energy solutions, including renewables, nuclear, energy efficiency, storage, CCS, CCU, carbon removals, geothermal and hydro. The Industrial Alliance on Small Modular

Reactors, launched today, is the latest initiative to enhance industrial competitiveness and ensure a strong EU supply chain and a skilled workforce. An important benefit of these efforts is a lower dependence on fossil fuels thanks to an 80% fall in their consumption for energy from 2021 to 2040. The post-2030 policy framework will be an opportunity to develop these policies further and complement them with social and industrial policies to ensure a smooth transition away from fossil fuels.

Read More

European Commission, 06-02-24

https://ec.europa.eu/commission/presscorner/detail/en/ip_24_588

ECHA launches new chemicals database

2024-01-30

ECHA CHEM is our new solution for publishing information on chemicals. The first release, available now, includes information from all REACH registrations – and there is more to come.

Helsinki, 30 January 2024 – ECHA maintains the largest chemicals database in the European Union (EU), combining industry-submitted data with information generated in the EU's regulatory processes. ECHA CHEM is the new solution to share with the public the growing amount of information hosted by the Agency.

In the first version of ECHA CHEM, you can find information from all the over 100 000 REACH registrations that companies have submitted to ECHA. Later this year, the database will be expanded with the redesigned Classification and Labelling Inventory, followed by the first set of regulatory lists.

Mercedes Viñas, ECHA's Director of Submissions and Interaction said:

"ECHA CHEM is a significant step forward in enhancing our service for sharing data on chemicals gathered through ECHA's current activities. It makes the information available online within a stable system and in a user-friendly manner."

Kai Taka-aho, Director of Information Systems said:

"ECHA CHEM has been designed to be flexible technical platform capable of handling large amounts of data, and adjustable for different needs arising for example from new tasks to be assigned to ECHA. So, one could say with the technological choices made ECHA CHEM is really a future-proof solution."

Background

ECHA's current Information on chemicals platform, launched in 2016, grew rapidly and contains today information on over 360 000 chemicals. In 2022, ECHA announced that it would create a new system for publishing chemicals data. ECHA CHEM allows the Agency to better handle the growing diversity and quantity of data, while taking advantage of technological advancements.

Read More

ECHA, 30-01-24

https://echa.europa.eu/-/echa-launches-new-chemicals-database

ECHA consults on recommending five substances for REACH authorisation

2024-02-07

The Agency is also inviting comments regarding the implications of adding a new hazard to dibutyl phthalate (DBP) which is already on the Authorisation List. The consultations are open until 7 May 2024.

Helsinki, 7 February 2024 – The European Chemicals Agency (ECHA) is considering recommending the following substances for the REACH Authorisation List:

- Melamine;
- Bis(2-ethylhexyl) tetrabromophthalate covering any of the individual isomers and/or combinations thereof (TBPH);
- S-(tricyclo[5.2.1.0 2,6]deca-3-en-8(or 9)-yl) O-(isopropyl or isobutyl or 2-ethylhexyl) O-(isopropyl or isobutyl or 2-ethylhexyl) phosphorodithioate;
- Diphenyl(2,4,6-trimethylbenzoyl)phosphine oxide; and
- Barium diboron tetraoxide.

ECHA is looking for further information on the uses of these substances in scope of authorisation, their possible exemptions from the authorisation requirement and on the structure and complexity of the supply chains. REACH registrants are, therefore, encouraged to update their use information alongside sending their comments.

The European Commission is calling for information separately on the possible socio-economic impacts of adding these substances to the Authorisation List. The information will be passed on directly to the Commission and will not be considered by ECHA.

Melamine

The identification of melamine as a substance of very high concern is currently being challenged before the General Court of Justice. Ongoing actions before the Court are, however, not considered legitimate grounds for postponing or delaying ECHA's recommendation. The conclusion of the cases will be assessed when available.

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Bis(2-ethylhexyl) tetrabromophthalate (TBPH)

The Commission has also requested ECHA to carry out an investigation on flame retardants, which will cover Bis(2-ethylhexyl) tetrabromophthalate (TBPH), among other substances. This report will support the Commission to decide whether to request ECHA to prepare a restriction dossier. A call for evidence for this investigation is open until 5 April, and ECHA invites interested parties to provide information on TBPH via this call for evidence as well.

Considering that there is currently no decision yet on whether a REACH restriction process will be initiated on TBPH nor what could be the potential uses in scope of such a restriction, TBPH will remain for the moment in the draft recommendation for potential inclusion to REACH Authorisation List. A decision if it is included in the final recommendation will be taken later.

More information about the uses and reasons for including these substances in the draft recommendation for authorisation is in the annex.

Background

ECHA regularly recommends substances from the Candidate List to be included in the Authorisation List by the Commission. It has prioritised these five substances from the Candidate List of substances of very high concern following the approach agreed with Member States. The draft recommendation is based on an assessment of the registration data and other available information, and an initial discussion with the Member State Committee.

The Member State Committee will prepare an opinion on ECHA's draft recommendation considering the feedback gathered in this consultation. Following the Committee's opinion and the information received during the consultation, ECHA will send its final recommendation to the European Commission in spring 2025. This will be ECHA's twelfth recommendation. The Commission will decide which substances to include in the Authorisation List and on the specific conditions for each substance.

If a substance is included in the Authorisation List, it cannot be placed on the market or used after a given date unless an authorisation is granted for a specific use. Companies that are using, manufacturing or importing these substances can apply for authorisation.

Read More

ECHA, 07-02-24

https://echa.europa.eu/-/echa-consults-on-recommending-five-substances-for-reach-authorisation

ECHA sets out strategic goals for next five years

2024-01-30

The European Chemicals Agency (ECHA) has today published its Strategy Statement 2024-2028. The strategy details the agency's goals and priorities over the next five years to protect health and the environment through its work for chemical safety.

Helsinki, 30 January 2024 - With its new strategy, ECHA will deliver on its existing wide legal mandate, build on its expertise and experience, collaborate with our stakeholders and partners, implement new tasks and support the ambition of the EU policy goals on chemicals. In support of these actions, we will also invest in our people so they too are ready for ECHA's future work.

Dr Sharon McGuinness, ECHA Executive Director, said:

"I am happy to present our new Strategy Statement, which will drive ECHA's direction and priorities for the next five years. Our new vision, chemical safety through science, collaboration and knowledge will guide us as we deliver our strategy and our values of integrity, transparency, collaboration and innovation will inform our actions. We look forward to working with our staff, partners and stakeholders in delivering our strategy."

Paul Krajnik, Chair of ECHA's Management Board, said:

"The new ECHA Strategy reflects the broadening of our legal mandate in support of the European Union's ambitious goals on chemical safety, and its commitment to the protection of health and the environment. This new strategy equips ECHA to continue its successful implementation of its agenda into the future."

Main elements of the strategy - goals and priorities

- Be a trusted chemicals agency
- Respond to emerging challenges and changes in our legal landscape
- Communicate and engage

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- Lead on chemical knowledge and expertise; and
- Invest in people and organisational excellence.

Read More

ECHA, 30-01-24

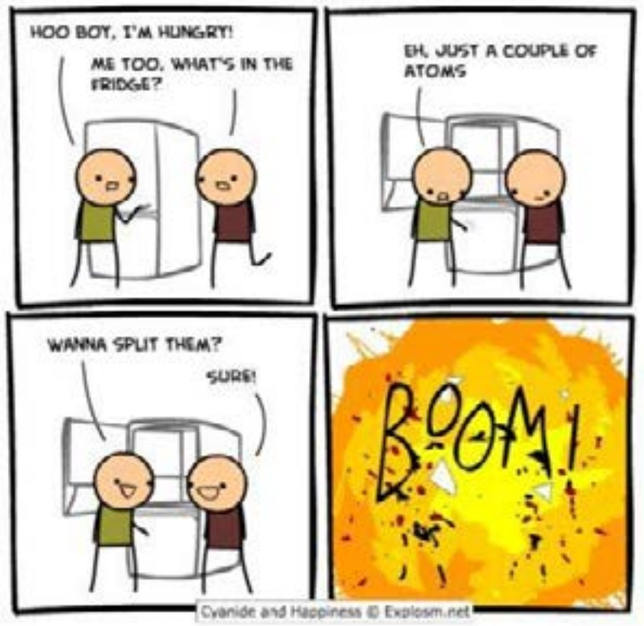
https://echa.europa.eu/-/echa-sets-out-strategic-goals-for-next-five-years

Janet's Corner

FEB. 16, 2024

Splitting the Atom

2024-02-16



https://explosm.net/

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Hazard Alert

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Sodium Fluoroacetate

2024-02-16

Sodium fluoroacetate, known in pesticide form as 1080, is the organofluorine chemical compound with the formula FCH_2CO_2Na. [1,2]

USES [2,3]

Pesticide Use

Sodium fluoroacetate is used as a pesticide, especially for mammalian pest species. Farmers and graziers use the poison to protect pastures and crops from various herbivorous mammals. In New Zealand and Australia, it is also used to control invasive non-native mammals that prey on or compete with native wildlife and vegetation.

In Australia, sodium fluoroacetate is seen as a critical component of the integrated pest-control programs for rabbits, foxes, wild dogs, and feral pigs. Since 1994, broad-scale fox control using 1080 meat baits in Western Australia has significantly improved the population numbers of several native species and led, for the first time, to three species of mammals being taken off the state's endangered species list.

Worldwide, New Zealand is the largest user of sodium fluoroacetate. This high usage is attributable to the fact that, apart from two species of bat, New Zealand has no native land mammals, and those that have been introduced have had devastating effects on vegetation and native species. 1080 is used to control possums, rats, stoats, and rabbits.

Sodium fluoroacetate is used in the United States to kill coyotes. Prior to 1972 when the EPA cancelled all uses, sodium fluoroacetate was used much more widely as a cheap predacide and rodenticide; in 1985, the restricted-use "toxic collar" approval was finalised.

1080 is also used as a rodenticide in Mexico, Japan, Korea, and Israel.

EXPOSURE SOURCES & ROUTES OF EXPOSURE [3]

Exposure Sources

Occupational exposure to sodium fluoroacetate may occur through dermal contact with this compound at workplaces where sodium fluoroacetate is produced or used. Under the current permitted use pattern there will be no exposure of this compound to the general public.

Routes of Exposure

Sodium fluoroacetate can affect the body if it is inhaled, if it comes into contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin.

HEALTH EFFECTS [4]

Acute Health Effects

- Contact can irritate and burn the skin and eyes and may affect vision.
- Breathing sodium fluoroacetate can irritate the nose and throat.
- Breathing sodium fluoroacetate can irritate the lungs causing coughing and/or shortness of breath. Higher exposures can cause a build-up of fluid in the lungs (pulmonary oedema), a medical emergency, with severe shortness of breath.
- Sodium fluoroacetate can cause nausea, vomiting, diarrhoea and abdominal pain.
- Over exposure can cause hallucinations, twitching of the muscles, convulsions and serious heart rhythm changes which can cause death.

Carcinogenicity

- Sodium fluoroacetate has not been tested for its ability to cause cancer in animals.

Other Effects

- There is limited evidence that sodium fluoroacetate may damage the testes.
- Sodium fluoroacetate may damage the kidneys.
- Repeated exposure may affect the liver and thyroid gland.

SAFETY

First Aid Measures [5]

- **If inhaled:** If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.
- **In case of skin contact:** Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.
- **In case of eye contact:** Flush eyes with water as a precaution.

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- **If swallowed:** Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

Workplace Controls & Practices [4]

- Avoid contact with skin, eyes and clothing.
- Wash hands before breaks and immediately after handling the product.

Personal Protective Equipment [5]

The following personal protective equipment is recommended when handling sodium fluoroacetate:

- **Eye/face protection:** Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).
- **Skin protection:** Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands. The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.
- **Body Protection:** Complete suit protecting against chemicals. The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.
- **Respiratory protection:** Where risk assessment shows air-purifying respirators are appropriate use a full-face particle respirator type N100 (US) or type P3 (EN 143) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

REGULATION

United States

OSHA: The United States Occupational Safety & Health Administration has set the following Permissible Exposure Limits (PEL) for sodium fluoroacetate:

- General Industry: 0.05 mg/m3 (Skin);

- Construction Industry: 0.05 mg/m3 TWA (Skin)

ACGIH: The American Conference of Governmental Industrial Hygienists has set a Threshold Limit Value (TLV) for sodium fluoroacetate of 0.05 mg/m3 TWA (Skin)

NIOSH: The National Institute for Occupational Safety and Health has set a Recommended Exposure Limit (REL)for sodium fluoroacetate of 0.05 mg/m3 TWA (Skin), 0.15 mg/m3 STEL (Skin)

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Scientists Develop Eco-Friendly "Magnet" To Battle Microplastics

2024-02-13

The college's Department of Biosystems and Agricultural Engineering (BAE) is partnering with the UK Department of Chemical and Materials Engineering to tackle the tiny, often unseen, particles of plastic now found in the world's oceans.

What are NADES?

The research, published in Scientific Reports, centers on an intriguing solution: using Natural Deep Eutectic Solvents (NADES) to capture and remove these miniature particles from water.

Plastic is a durable, cheap material, making it a staple in daily life. However, its strength is also its environmental downfall.

Plastics don't break down easily, leading to massive piles of waste. Over time, these plastics break into smaller fragments. The smallest, nano-plastics, are so tiny they can't be seen without a microscope. Their size makes them a significant hazard, as they can be ingested by marine life and enter the human food chain.

"Think of NADES as a kind of 'magnet' that specifically attracts and holds onto these small plastic pieces," said Czarena Crofcheck, BAE professor and study co-author. "Basically, the NADES mix with the water and 'stick' to the plastics, pulling them out of the water."

The molecules in the NADES can form bonds with the molecules in the plastics, a bit like how Velcro works: one side sticks to the other. This property makes NADES particularly good at grabbing onto and holding these plastic particles.

NADES are also unique because they are effective and environmentally friendly. They're made from natural materials, meaning they don't add more pollutants to the environment while cleaning up the existing ones.

"Our approach introduces the concept of deep eutectic solvents, which are unique in their composition and behavior," Shi said.

"Derived from natural sources like mint plants and coconuts, these solvents transform from solid to liquid when mixed, creating an effective medium to extract these tiny plastic particles from water."

The researchers focused on polyethylene terephthalate (PET) like that found in plastic bottles, polystyrene (PS) used for materials such as

Plastic pollution is a pressing environmental issue, and University of Kentucky Martin-Gatton College of Agriculture, Food and Environment researchers are leading the charge with an innovative solution.

packaging peanuts and polylactic acid (PLA) used for plastic films and food containers. Using computer simulations, they could see how these interactions work on a minute scale.

Discovery

Their experiments revealed that certain NADES are particularly good at extracting these types of plastic from water. This discovery was crucial, offering a targeted approach to removing plastics.

The research presents a new, effective way to clean waters of micro- and nano-plastics. Additionally, it provides a potential pathway to recycle and reuse these plastic particles, resulting in significant environmental and economic benefits.

"Imagine being able to lessen our overall environmental footprint," Crofcheck said. "With contributions from chemical engineering for molecular simulations, we've been able to deepen our understanding of why these solvents are more effective at pulling plastics out of water. This theoretical understanding is crucial for advancing practical applications and future research."

While the research is still in its developmental stages, the team is optimistic about its potential applications.

"Our next step is to test these solvents on a larger scale and in various environmental conditions," Shi said. "We think that NADES could be a game-changer in our fight against plastic pollution."

Technology Networks, 13 February 2024

https://technologynetworks.com

Engineered enzymes break down silicon–carbon bonds in siloxane, an emerging pollutant

2024-02-13

Volatile methylsiloxanes (VMSs) are a type of siloxane that can exist in ring or chain form. They are found in a wide range of consumer products, including textiles, electronics, cosmetics, and medical equipment due to unique properties such as water resistance, flexibility and low chemical reactivity.

In 2018, three cyclic VMSs were identified as 'substances of very high concern' under the EU's Registration, Evaluation, Authorization and

Silicon–carbon bonds have been broken down by a cytochrome P450BM3 enzyme engineered for just that task.

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Restriction of Chemicals regulations. As they are also highly volatile, VMSs can get into the air, where they can remain for several days.

'It is important to understand which synthetic compounds can be biodegraded to guide responsible use of the chemicals that enable modern life,' says Nicholas Sarai, a former PhD student at the California Institute of Technology and first author of study. 'Our research puts forward the first enzyme that can definitively break the bond between silicon and carbon,' he adds.

Prior studies suggest that hydroxylation of a C–H in the methyl group adjacent to the silicon in VMS precedes the oxidation – and subsequent breaking – of its silicon–carbon bond. Cytochrome P450 enzymes are known to hydroxylate C–H bonds in alkyl groups. The team hypothesised that it might also be able to hydroxylate the similarly strong C–H bonds in siloxane.

The team picked cytochrome P450BM3 because of its self-sufficiency and high catalytic activity. The researchers then evaluated a number of enzyme variants they created, using a variety of mutagenesis strategies, for their ability to hydroxylate C–H bonds in volatile siloxanes. Following the reaction of a siloxane substrate with these enzyme variants trace amounts of carbinol, a C–H hydroxylation product, and modest amounts of silanol were observed – indicators of silicon–carbon bond cleavage.

The team's starting enzyme variant showed some silicon–carbon cleavage activity on hexamethyldisiloxane, something not displayed by wild-type P450BM3. Several rounds of directed evolution brought about variants with a better ability to oxidise hexamethyldisiloxane. They then tested variants on a number of different siloxanes, discovering it could break down a number of different types, including cyclic siloxanes.

However, Sarai notes that 'despite using 5mM siloxane substrate, none of our enzymes are able to generate even 1mM of product.' But the team says that, underwhelming enzymatic activity notwithstanding, these engineered enzymes show biological activity on VMS is both possible and can be enhanced.

Currently, not all VMS are accessible to these enzymes and the concentration of them in various environments and waste streams is highly variable. 'The enzymes will need to exhibit higher catalytic activity and different binding kinetics to perform efficiently at these varied concentrations,' says Sarai.

So although engineered enzymes such as these may eventually be able to clean up siloxane pollution, they must first be engineered to oxidise multiple siloxane methyl groups. 'Many research questions need to be addressed before these enzymes can be applied,' says Sarai.

'Given the ubiquity and magnitude of total siloxane emissions into urban air, their atmospheric lifetimes and potential for bioaccumulation, safely degrading these chemicals is important,' says Betty Molinier at the University of California, Berkeley, who was not involved in the work. But Molinier points out that the byproducts of these enzymatic reactions, such as formaldehyde, could be harmful from a health and environmental perspective. 'Although only a small amount of formaldehyde is produced in their experiments, I think it would be useful if future work included more investigation into the quantification of byproducts.'

Chemistry World, 13 February 2024

https://chemistryworld.com

Thermally engineering templates for highly ordered self-assembled materials

2024-02-14

Researchers at the University of Illinois Urbana-Champaign and the University of Michigan Ann Arbor have developed a template material that carries almost no heat and therefore stops heat transfer between the template material itself and the solidifying eutectic material. They accomplished this by forming the template from a material with very low thermal conductivity, ultimately resulting in highly organized self-assembled microstructures.

The results of this research were recently published in the journal Advanced Materials.

"The key novelty of this research is that we carefully controlled the flow of heat. By controlling the flow of heat, the pattern becomes far better and more regular than before because we're controlling more of the parameters. Previously, the template controlled the flow of atoms, but the heat flows were uncontrolled," says Paul Braun, a professor of materials science and engineering and director of the Materials Research Laboratory, who led this research along with postdoctoral researcher Sung Bum Kang.

Self-assembled solidifying eutectic materials directed by a template with miniature features demonstrate unique microstructures and patterns as a result of diffusion and thermal gradients caused by the template.

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Eutectic materials are a homogeneous mixture that have a melting point that is lower than the melting point of either constituent. Common examples of eutectic systems include solder (a mixture of lead and tin) and mixtures of salt (sodium chloride) and water. When eutectic mixtures are cooled from the liquid phase, they separate into two materials that form a pattern at the solidifying front.

The material doesn't separate into just two large layers. Instead, it forms structures including a multi-layered structure (lamellar), like a tiered cake, a rod-like structure or even more complex structures. The resulting microstructure of the material, however, is only well-ordered over short distances. Instabilities that arise in the self-assembly process lead to defects in the microstructure and affect the properties of the resulting solid material. For many applications, such as optics or mechanics, very good order over long distances is required.

The solidification process can be controlled by a template consisting of pillars that act as barriers to the movement of atoms and molecules. This forces the structure to form a more regular pattern when it solidifies. But the issue, Braun explains, is that the pillars carry a lot of heat, and instead of having a flat, solidifying front, the shape of the front becomes complex. This leads to irregular patterns and long-range disorder.

"We figured out how to make the pillars so that they were really good insulators," Braun says. "So all of the heat is only flowing through the material that's solidifying. The template is now only acting as a barrier to the flow of atoms, but almost no heat is moving between the solidifying material and the template."

The researchers explored template materials with lower thermal conductivities than the eutectic system and found that low thermal conductivity template material resulted in highly organized microstructures with long-range order. Specifically, they used porous silicon (essentially a silicon foam) that is at least 100 times less thermally conductive than crystalline silicon. The template material's low thermal conductivity minimizes the flow of heat in the "wrong" direction.

"The thermal conductivity of the template is a critical factor in determining the rate of heat transfer during the solidification process," Kang says. "The porous silicon we used for the templates has a low thermal conductivity and led to about 99% uniformity of the unit cells of the structure."

In comparison, with higher thermal conductivity crystalline silicon pillars, the expected pattern is only present in 50% of the unit cells.

"This means we can design eutectic materials with highly predictable and consistent properties. This level of control is crucial for applications where uniformity directly impacts performance," Kang says.

Phys Org, 14 February 2024

https://phys.org

Novel Design Improves CAR T-Cell Therapy for Childhood Leukemia

2024-02-13

Immunotherapy that reprograms a patient's own immune cells to target a cancer-specific protein, CAR T–cell therapy, has shown success in treating some relapsed leukemias. However, sometimes the treatment is unsuccessful because cancer cells that do not have the targeted protein can still grow, escaping the therapy and causing a relapse. The relapse rate for AML is high, leading to a poor prognosis for the disease overall.

The St. Jude group thought it might be possible to overcome the problem of immune escape in AML models by targeting two different cancer-related proteins instead of just one. Others have attempted a similar approach but have encountered problems with the structure of the bispecific CAR. The scientists overcame these problems by adding a small peptide to the CAR to serve as the binder for the second targeted protein, then confirmed their results with computational structural analysis of their improved constructs.

"One of the most exciting aspects of the study is that this approach can be widely extrapolated to other tumors," said senior corresponding author Paulina Velasquez, MD, St. Jude Department of Bone Marrow Transplantation and Cellular Therapy. "We focused on leukemia, but combining bispecific CAR design with computational predictions can be widely extrapolated for other tumors such as solid and brain tumors."

Improving dual targeting by adding a second, small barcode scanner

The CAR the researchers created is a unique design. It is a single molecule, which includes the region of an antibody that binds a specific target (its antigen) and one short peptide that binds a separate target.

"The two different binding domains of the CAR are like having two barcode scanners instead of one, looking for their appropriate barcode, the targeted cancer-related proteins," Velasquez said. "Normally, a CAR has a single barcode scanner. Here, we placed two slightly different barcode scanners on top of each other, and if either one detects an appropriate target barcode, the anti-cancer immunotherapy response activates."

St. Jude Children's Research Hospital scientists improved chimeric antigen receptor (CAR) T–cell immunotherapy for acute myeloid leukemia (AML), demonstrating better efficacy in the lab. published today in Cell Reports Medicine.

The two binding domains are connected by a linker to allow for the binding of two different cancer-related proteins. This differs greatly from previous dual-targeting approaches in the field, which typically used two full antibody-based binding segments.

"We showed the value in finding creative ways to perform dual-antigen targeting," said first author Jaquelyn Zoine, PhD, St. Jude Department of Bone Marrow Transplantation and Cellular Therapy. "Prior bispecific CAR approaches use two antibody-based single-chain variable fragments, which are physically large molecules and can get in each other's way, sometimes leading to poor or inefficient binding. Our approach instead added a small peptide, enabling our CAR to engage either platform to prevent immune escape."

The dual-targeted CARs performed better than single-targeted CARs in both in vitro and in vivo experiments, demonstrating promise for improving CAR T–cell function.

Untangling two-target constructs' performance with artificial intelligence

"We showed a proof of principle to explain and potentially expand the CAR design repertoire," said co-author M. Madan Babu, PhD, FRS, St. Jude Center of Excellence for Data-Driven Discovery director, and the George J Pedersen Endowed Chair in Biological Data Science in the Department of Structural Biology. "But then comes the challenge. How do we know what linkers to choose? How do we know how much physical flexibility is needed?"

Since the physical structure of the targeting molecule and its linker that bridges the two binding domains can cause internal interference that prevents binding to the targets on the cancer cell, identifying what type of linkers were more common in effective therapies could lead to future improvement. Computational structure predictions and comparing structures with experimental results confirmed to the St. Jude group that shorter, more flexible linkers would work better in their models.

"If we have a rigid linker connecting the barcode scanners, it can only scan a restricted volume on the cancer cell, making it less effective in finding the targets," Babu said. "We found when you have a linker of sufficient flexibility and shorter length so it doesn't fold onto itself, it can scan a

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much larger volume and is more likely to find the target proteins on the cancer cell. Then you have a more effective pair of barcode scanners that work together."

"We are one of few groups in the world to use AI-based structure prediction tools for CAR design," said second author Kalyan Immadisetty, St. Jude Department of Bone Marrow Transplantation and Cellular Therapy. Immadisetty confirmed the association between short, flexible linkers and greater anti-cancer efficacy by comparing 3D-modeled structures. This information supported the performance of the CAR in real experimental outputs.

"We were excited that the structural predictions supported our experiments that informed us a short and flexible linker would be the best configuration," Zoine said. "While we performed the experiments, Immadisetty found the structural components correlating almost exactly with what we were showing functionally, even when we switched one of the targeting antibody binding domains. We have now introduced the idea that these AI prediction tools can be extended to other CAR constructs.

"Most importantly, others can now use our computational approach for designing their CARs," Immadisetty said. "And hopefully, it will help them understand the efficacy of their CAR technology and lead to overall improvements for leukemia and other malignancies."

Technology Networks, 13 February 2024

https://technologynetworks.com

Eco-Friendly or Health Hazard? Scientists Uncover Hidden Dangers of "Green" Cleaning Products

2024-02-11

Researchers say there needs to be better regulation and more guidance for consumers about how safe cleaning products really are.

Potentially harmful

The study, published by The Royal Society of Chemistry in the journal Environmental Science: Processes & Impact, found that fragranced cleaning products can be potentially harmful for the air quality in people's homes.

New research indicates that many cleaning products marketed as "green" release the same amount of hazardous chemicals as conventional cleaning products.

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Cleaning products emit a wide range of volatile organic compounds (VOCs), including some which are hazardous or can undergo chemical transformations to generate harmful secondary pollutants. In recent years, "green" cleaners have become increasingly popular, with an implicit assumption that these are better for our health and the environment. But the University of York research found this was not the case.

Secondary pollutants

As part of the study, the VOC composition of 10 regular and 13 green cleaners was examined by researchers. Green cleaners generally emitted more monoterpenes than regular cleaners, resulting in increases in harmful secondary pollutant concentrations following use, such as formaldehyde and peroxyacyl nitrates.

The study found that the fragrance ingredients of these products were the source of the volatile monoterpenes. As levels of these types of pollutants increase in the home, susceptible people can develop breathing problems or irritation of the eyes, nose, throat, or skin. Repeated exposure to high concentrations of formaldehyde can possibly lead to cancer in some cases.

Misleading consumers

Ellen Harding-Smith, Environmental Chemistry researcher from the Department of Environment & Geography, said: "Our research found there is no strong evidence to suggest that clean green products are better for indoor air quality compared to regular products.

"In fact, there was very little difference. Many consumers are being misled by the marketing of these products which could be damaging the air quality in their homes as a result – potentially putting their health at risk. For so many products on the supermarket shelves, green doesn't mean clean."

Compositional differences

The research was funded by the EPSRC and the project is called IMPeCCABLE. It is a collaboration between the University of York's Department of Environment and Geography, the Department of Chemistry, and the Wolfson Atmospheric Chemistry Laboratory.

Miss Harding-Smith, who is a PhD Candidate, added: "The study highlights potential compositional differences in the formulations of regular and green cleaners, for which there is currently very little information on in the available literature.

Mitigating harm

"Manufacturers really need to be so much clearer about what's in these products and make clear how to mitigate their harm. For example, just improving ventilation and opening windows when using these cleaning products makes air quality at home so much better."

Sci Tech Daily, 11 January 2024

https://scitechdaily.com

Unusual bridging fluorine discovered in one-of-a-kind interhalogen ion

2024-02-09

Tetracoordinated fluorine atoms are known in ionic compounds, for example in CaF2. And μ4-fluorine atoms are present in the tetrahydrogen pentafluoride ion and a handful of metal compounds.

Last year, a team led by Florian Kraus from the Philipps University of Marburg in Germany, synthesised [Br3F16]–, 2 which has a triple-coordinated central fluoride ion. Now, building on their previous work, Kraus and co-workers have used a sterically demanding [NMe4]+ counter ion to form the bulkier μ4-fluorine containing interhalogen ion, [Br4F21] –.

Halogen fluorides are known for their extreme reactivity and the synthesis did not come without its challenges. The team first tried reacting pure BrF5 with [NMe4]F but a violent reaction between the two compounds caused a small explosion and a day's work was lost in an instant. On searching for an alternative method they came across research by Karl Christe from 19893 that helped them to reliably access [NMe4][BrF6] and they went on to attempt a controlled reaction of [NMe4][BrF6] with excess BrF5 at low temperatures. It worked. Graham Saunders, a synthetic fluorine chemist from the University of Waikato in New Zealand, comments 'technically it's very difficult work and it's very elegant'.

For the first time, chemists have synthesised an interhalogen compound exhibiting a unique central fluorine atom coordinated by four BrF5 groups.1 The one-of-a-kind interhalogen ion in [NMe4][Br4F21]·BrF5 represents the first example of a central tetracoordinated fluorine bridging to neither metal nor hydrogen atoms.

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Deciphering the compound's structure also presented a challenge as it initially appeared very complex. However, by focusing on the centres of the ions and BrF5 molecules, the team discovered its crystal structure was similar to the MgAgAs-type structure. 'Although the two compounds could not be more chemically different, they are structurally closely related,' says Marburg team member Martin Möbs. Additional quantum calculations reveal that the μ4-fluorine–bromine bonds are best described as ionic.

'To encapsulate a fluoride ion in a non-metallic inorganic framework such that it's bound to four different moieties is really quite extraordinary, because normally you would not anticipate that kind of bonding arrangement,' comments Thomas Lectka, an organofluorine chemist from Johns Hopkins University, US. 'It's an interesting result and I think it will spur more work into the halogens with fluorine,' adds Saunders.

But while the μ3-fluorine and μ4-fluorine polynuclear anions of BrF5 have now been isolated, Möbs concludes that 'the anion in which the fluoride ion is surrounded by two BrF5 molecules, [Br2F11]–, is still missing.'

Correction: The images were updated on 12 February 2024

Chemistry World, 09 February 2024

https://chemistryworld.com

"Zombie" COVID particles may be responsible for lethal disease

2024-02-05

Why some coronaviruses are relatively harmless while others are incredibly lethal is still a bit of a mystery. Some answers lie in the proteins each individual virus uses to enter human cells, but what exactly makes SARS-CoV-2 so severe in some people and innocuous in others is unclear.

An impressive new study led by researchers from UCLA is offering a novel hypothesis to explain SARS-CoV-2 severity. Using an AI-driven machine-learning system the researchers discovered SARS-CoV-2 is broken down into fragments in a human body, and this viral debris can uniquely resemble endogenous peptides that overstimulate the immune system. This may play a significant role in the strange variable severity of disease from person to person.

Following the emergence of SARS-CoV-2 in 2020 there are now seven different coronaviruses known to infect humans.

"The textbooks tell us that after the virus is destroyed, the sick host 'wins,' and different pieces of virus can be used to train the immune system for future recognition," says corresponding author Gerald Wong.

But the story of a virus isn't exactly as simple as that. After a virus is neutralized by the immune system it is rapidly broken down, or dissolved, into tiny fragments. It has generally been assumed this stage of viral degradation was innocuous, but recent research has suggested some of these smaller viral fragments could trigger innate immune responses that account for severe disease associated with hyper inflammation.

To investigate this idea in the context of COVID, the researchers tracked all the possible peptide combinations that could be created through the degradation of SARS-CoV-2 proteins. They used a machine-learning system to measure the pro-inflammatory characteristics of all these potential peptides and discovered several of these viral fragments closely resemble molecules our immune system uses to heighten inflammatory responses.

"We saw that the various forms of debris from the destroyed virus can reassemble into these biologically active 'zombie' complexes," explains Wong. "It is interesting that the human peptide being imitated by the viral fragments has been implicated in rheumatoid arthritis, psoriasis and lupus, and that different aspects of COVID-19 are reminiscent of these autoimmune conditions."

The researchers then directly compared these SARS-CoV-2 viral fragments to debris that comes from a more harmless common-cold-causing coronavirus (HCoV-OC43). The fragments were very different, and the OC43 debris was found to not at all stimulate the immune system in the same way as SARS-CoV-2.

Even more interestingly, the researchers looked at what kinds of gene expression were stimulated by these SARS-CoV-2 viral fragments. These novel peptides were found to trigger similar patterns of expression to the full virus.

"What's astonishing about the gene expression result is there was no active infection used in our experiments," Wong notes. "We did not even use the whole virus – rather only about 0.2% or 0.3% of it – but we found this incredible level of agreement that is highly suggestive."

So these findings may somewhat account for why SARS-CoV-2 triggers more severe disease than its common-cold coronavirus counterparts. But

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the study can only speculate as to why the virus's effects are so variable from person to person.

Here the researchers indicate the striking uniqueness in each individual person's enzyme efficiency could likely account for why some people don't even notice they have COVID, while others end up struggling in hospital. Essentially, each of us break down foreign particles differently, and these unique differences may be responsible for how mild our illness is.

"... proteolytic degradation of SARS-CoV-2 is likely to be heterogeneous, as individual hosts display distinctive patterns of enzyme efficiencies varying routinely by fourfold to 50-fold, with protein expression being 'noisy' even at the single cell level," the researchers write in the new study. "That proteolytic degradation of SARS-CoV-2 is expected to be drastically different among hosts may explain why the infection outcomes of SARS-CoV-2 are so heterogeneous, ranging from asymptomatic hosts to fatalities."

New Atlas, 05 February 2024

https://newatlas.com

Testosterone alters isoflurane sensitivity

2024-02-18

Researchers have sometimes reported sex differences in how people recover from anesthesia—specifically, that men regain consciousness more slowly than women. But the phenomenon is not always observed, making it controversial. In addition, clinical studies of anesthesia are challenging, and have historically focused on men.

While studying how consciousness comes back online as an anesthetic drug called isoflurane wears off, Penn postdoctoral researcher Andrzej Wasilczuk observed that anesthetized female mice are more likely to retain certain reflexes, go under more slowly, and wake up more quickly than male mice. By testing castrated male mice and female mice with ovaries removed, Wasilczuk and colleagues determined that testosterone drove the observed reawakening differences. Castrated male mice, like female mice, were more likely to right themselves from a vulnerable belly-up position while anesthetized. Treatment with testosterone or a downstream metabolite, estradiol, made the castrated mice more sensitive to the effects of isoflurane. Conversely, blocking the enzyme that converts testosterone to estradiol made uncastrated male mice less sensitive.

Not many drugs are as widely used yet poorly understood as anesthetics. "We've used them for over a century, but nobody understands how they work," says Alex Proekt, an anesthesiologist and neuroscientist at the University of Pennsylvania.

Using a whole-brain activity imaging technique, the researchers found sex differences in activity in part of the hypothalamus, a brain region with roles in both sleep and the endocrine system.

The scientists revisited human data from a study of reacquiring consciousness after isoflurane treatment and found that men were less likely than women in that trial to respond to stimuli, like an instruction to squeeze a hand. The difference is undetectable using electroencephalography (EEG), a noninvasive measure of brain activity, which anesthetists use to monitor unconsciousness. Proekt says this lack of detection is because the hypothalamus is deep in the brain—too deep to detect using the external electrodes that EEG relies on. That may be part of why any sex difference has been so hard to identify for certain in people.

According to Margaret Sedensky, a University of Washington anesthesiologist who studies anesthetic mechanisms, the work is interesting, but the mechanistic relationships will need to be examined further. Although the mouse studies used a drug concentration the researchers confirmed was the same in males and females, it's possible that in humans, attributes correlated with sex could cause different amounts of drug to reach the brain or affect the rate of drug metabolism, she says in an email. In addition, the study focused on a single inhaled anesthetic, whereas human patients anesthetized for surgery usually receive a mixture of painkillers and multiple anesthetics.

Fortunately, becoming aware during anesthesia is quite rare. But the research suggests it might happen more often in people with lower testosterone, such as cisgender women.

C&EN, 18 January 2024

https://cen.acs.org

Discovery of new plant protein fold may be seed for anti-cancer drugs

2024-02-14

Cyclic peptides are an emerging and promising area of drug research.

The new study, led by U-M College of Pharmacy researchers Lisa Mydy and Roland Kersten, revealed a mechanism by which plants generate cyclic peptides. The research is published in the journal Nature Chemical Biology.

University of Michigan researchers are celebrating their discovery of a new plant biochemistry and its unusual ability to form cyclic peptides—molecules that hold promise in pharmaceuticals as they can bind to challenging drug targets.

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Mydy identified the new plant protein fold and its novel chemistry, which she said had never been seen before. The protein can generate cyclic peptides, one of which holds potential as an anti-cancer drug.

"It's extremely exciting," said Mydy, a postdoctoral research fellow in the Department of Medicinal Chemistry. "This type of discovery doesn't happen too often."

Mydy and colleagues studied the biosynthesis of a class of macrocyclic peptides found in plants and known for their potential use as therapeutic drugs. They identified a "fascinating new protein fold that has a really unusual mechanism to form cyclic peptides. It is a new biochemistry that we have not seen before," Mydy said.

The researchers also examined peptide cyclase, a protein called AhyBURP found in the roots of the peanut plant, a representative of the founding Unknown Seed Protein, or USP-type, which in turn is part of the BURP-domain protein family.

"There was no experimental information on our protein AhyBURP," Mydy said. "The only hint we had for function was that the protein needed copper to cyclize a peptide."

The research team studied the protein structures with X-ray crystallography and used the Advanced Photon Source at Argonne National Laboratory. In the process, they found that the "protein AhyBURP uses copper and oxygen in a unique way that we're still investigating," Mydy said.

"Most cyclic peptides need another enzyme to come in and do the cyclization chemistry," she said. "However, AhyBURP can do it within the same protein on itself. Other copper-dependent proteins function by attaching oxygen somewhere on the peptide. We don't observe that, and we want to know why. I see this as the first example of this type of chemistry that can happen with copper and oxygen within a protein."

The discovery of the new protein grew from ongoing work in Kersten's lab. As part of the U-M Natural Product Discovery Initiative, the Kersten lab aims to discover and research new plant-based chemicals that can become drugs and ultimately cure human diseases.

"We use a modern approach where we screen the genetic sequences of plants, searching for genes connected to new chemistry," said Kersten, assistant professor of medicinal chemistry at the College of Pharmacy.

"That's how we identified the cyclic peptide products and their underlying proteins as a target of interest."

This class of peptides is of interest because their cyclization properties make them more structured and stable, increasing their potential to be used as drugs.

Many drugs, including chemicals derived from living organisms, are cyclic, meaning that they can bind drug targets and remain intact in a patient for a desired time. Nature has evolved many biochemical solutions to produce such cyclic molecules.

Kersten has isolated other compounds made by the same protein family that have been shown to have suppressing effects on lung cancer cells in lab tests, so there is growing hope that this discovery will have potential as a future anti-cancer agent.

"Now that we know what the protein looks like for one of the BURP-domain proteins, we can test more ideas about how the protein may influence the chemical reaction between the peptide, copper and oxygen to form cyclic peptides," said Mydy, a structural biologist and enzymologist by training.

"It is a fantastic and challenging puzzle to figure out why this is happening and understand the structure. It's extremely exciting to be part of this type of discovery that may eventually lead to effective pharmaceutical therapeutics."

Phys Org, 14 February 2024

https://phys.org

Cannabis extract found to slow melanoma cell growth & trigger cell death

2024-02-08

Melanoma might only account for around 6% of skin cancers, but it's the cause of more than 80% of skin cancer deaths. This cancer is prone to metastasizing and has been shown to be highly resistant to traditional treatments. In a new study, researchers from Charles Darwin University (CDU) and RMIT in Australia have developed a non-traditional treatment: a cannabis extract that stops melanoma cells from dividing and triggers the process of programmed cell death.

A new study has found that an extract derived from the Cannabis sativa plant can inhibit the growth of melanoma cells and trigger cell death.

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"The damage to the melanoma cell prevents it from dividing into new cells, and instead begins a programmed cell death, also known as apoptosis," said Nazim Nassar, a co-corresponding author on the study. "This is a growing area of important research because we need to understand cannabis extracts as much as possible, especially their potential to function as anticancer agents. If we know how they react to cancer cells, particularly in the cause of cell death, we can refine treatment techniques to be more specific, responsive and effective."

Previous studies have suggested that certain compounds present in cannabis may have antitumor effects by acting on receptors in the endogenous cannabinoid – or endocannabinoid – system (ECS). The cannabinoid receptors CB1 and CB2, widely distributed in the central nervous and peripheral immune systems, influence various intracellular signaling pathways that regulate different processes, including gene transcription, cell motility, and apoptosis.

In the current study, the researchers tested the effect of PHEC-66, an extract derived from Cannabis sativa, on the growth of primary and secondary (metastatic) human melanoma cells. They found that PHEC-66 impeded the growth of all melanoma cell lines by interacting with CB1 and CB2 receptors. They also found that PHEC-66 inhibited the progression of the cell cycle, the series of events that takes place as a cell grows and divides. The sub-G1 and G1 phases were particularly affected; the G1 phase is when the cell prepares to divide by copying all of its DNA. In addition, the researchers observed that PHEC-66 influenced metabolic pathways by causing an accumulation of reactive oxygen species (ROS) in the melanoma cells, pushing them towards pro-apoptotic signaling pathways, while diminishing anti-apoptotic ones.

"All these actions together start the process of apoptosis and slow down the growth of melanoma cells," said the researchers.

The next step is to develop a targeted delivery system to deliver the extract to the melanoma cells in the body so that the researchers can proceed to pre-clinical trials to test PHEC-66's safety and efficacy.

"Advanced delivery systems still need to be fully developed, underscoring the importance of ongoing efforts to ensure the proper and effective use of these agents at target sites," Nassar said.

The study's findings have the potential to advance treatments not only for melanoma but also for other types of cancer.

"Clinical uses of cannabis extracts include treatment for anxiety, cancer-related symptoms, epilepsy, and chronic pain," said Nassar. "Intensive research into its potential for killing melanoma cells is only the start as we investigate how this knowledge can be applied to treating different kinds of cancers."

The study was published in the journal Cells.

New Atlas, 08 February 2024

https://newatlas.com

The chemistry of love

2024-02-12

Love is merely a madness, Shakespeare famously wrote. With musicians, artists and writers obsessed with the notion of love, it is not hard to understand why researchers are trying to use science to explain it. And what's chemistry got to do with it? We even use the word to describe this intangible feeling necessary to initiate and maintain romantic connections – this 'spark' felt between two people. The emotions we feel when we fall in love, develop attachments, build relationships and even break up are all linked to brain chemistry. Several neuropsychologists have investigated the brain during the different stages of love and have found explicit links between brain chemicals and human behaviour.

Homo sapiens have evolved three distinct brain systems for courtship, reproduction and parenting. The human need for romantic love is not just an artist's fantasy, it is a fundamental human need just like food, water and warmth. Love triggers a whole cocktail of neurochemicals because it is relevant to survival. There are chemical neurotransmitters and hormones that have been identified as being critical for this process such as oxytocin, vasopressin, dopamine, serotonin and testosterone.

The evidence for romantic love comes from neuroimaging and endocrinological research as well as theorising in in evolutionary human biology. Deep structures in the brain associated with reward and motivation, particularly the left ventral tegmental area, are heavily involved in the dopamine circuitry. Functional magnetic resonance imaging (FMRI) studies conducted by Helen Fisher of Indiana University, US, and colleagues indicate that romantic love is associated with dopaminergic pathways in the brain's reward system; activating the brain's dopamine rich regions – akin to the brain activity displayed when someone is addicted to opioids and cocaine. Hence, the longing for love can be considered a natural high.

It is generally agreed that there are at least two types of love we can identify – the first being romantic love, early stages involving passion and lust, the second more long-term, stable form of love. 'That period of intense emotions…often associated with the early stages of a romantic relationship,' is associated with passion and lust says Adam Bode, a romantic love and human mating researcher. 'The sort of love that is more stable and less intense and associated with long term pair bonds is coined companionate love and these two states are related… but they are distinct and have different biological profiles.'

There's chemistry behind every step of a romantic relationship, from the initial spark to the pain of break up, as Zahra Khan discovers

Pair bonding

'Nature gave us this system, for our evolution, for romantic love and attachment,' says Lucy Brown, a colleague of Helen Fisher and professor of neurology at the Albert Einstein College of Medicine in New York City, US. 'This incredible basic behaviour has been studied in prairie voles. These lower mammals have shown to have similar genetic markers to humans. The ventral pallidum, the part of the brain showing high activation, is responsible for pair bonding, and we share this system for pair bonding with lower mammals,' she explains. Pair bonding is the formation of a close relationship through courtship and sexual activity with a partner. The mating pair often produce offspring and the bond is often lifelong. Only 3% of animals pair bond and form lasting relationships. 'Neuroscientists have been able to look very closely at the neurochemistry of [prairie voles] brain. And indeed, they did find directly in those little animals that dopamine, vasopressin and oxytocin were involved in pair bonding.'

The basic science behind romantic love has been developed from animal observations and extrapolated. 'There are observable behaviours for pair bonding such as [animals] nest, they prefer each other, they're aggressive towards intruders, they travel together, they groom one another,' explains Bianca Acevedo, a research scientist at the University of California, Santa Barbara, in the US. In humans this is seen as a preference for a specific person known as romantic love.

The animal brain is always learning from reward and similarly the human brain's reward system is highly activated in feelings of love. 'Natural selection builds a brain that motivates you to do things that reproduce,' comments Loretta Breuning, author of Habits of a Happy Brain. While the reproductive strategy has always been the drive behind finding a mate in the animal kingdom, humans are more complex, social beings and the need for love doesn't always the need to produce offspring. 'To solidify the pair bond [in animals] it coincides with having offspring and raising them… If, within a few years, the pair bond does not create offspring, they don't generally stay together,' Acevedo says and though our brains have evolved for this purpose, romantic love still exists without the creation of offspring – and that is what is referred to as attachment. The brain system has developed over evolution not just for survival, but also through the need to protect each other.

Brown's research with Fisher hypothesised that romantic love was a developed form of a mammalian drive, to pursue preferred mates. 'Then we looked at the data, we saw that the activation in the brain for

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everybody was in this dopamine-rich area of the brain stem – not in the higher parts of the cognitive human brain. But in these lower parts, where reflexes are controlled, reflexes, like swallowing, even breathing,' says Brown.

Love is a drug

Our neural pathways are built from past experiences with these 'happy' chemicals that determines what turns them on and our brains are designed to recognise opportunity and anticipate reward. The initial stage of love is usually lust. That is, the instant attraction one feels in the presence of another – love at first sight, even. Individuals in this phase experience heightened dopamine and testosterone.

'Testosterone plays a role in sexual desire and sex drive… one of the theories was that testosterone in females increases to make them want to engage in more sex, and testosterone levels in males reduced in an attempt to make them less interested in sex with multiple partners,' says Bode. Along with oestrogen and dopamine, these chemicals are very important for our sex drive. Dopamine is associated with arousal and increased focus on the loved one. And because the drive for sex is a basic drive like hunger and thirst, the dopamine system in the hypothalamus is always engaged in romantic love.

Dopamine is the excitement you feel when you're about to meet a need giving you an indicator of where to invest your energy because the need is being met – just like food and water. 'And dopamine is released when you say "Yes, this is a good opportunity,"' says Breuning of when you first meet a potential partner. When we find an ideal person, we are biologically rewarded through dopamine to find that person both interesting and attractive.

For those couples that maintain romantic love, they still get their fix of dopamine 'when they see that person, when they think about them, their brain lights up, their dopamine centres light up', says Acevedo. In the longer term, where people go about their daily life and return to their mate, the individual is not solely concentrating on their partner and so this attachment phase is much calmer. Functional MRI studies show that this phase involves chemicals like oxytocin and vasopressin, which allow a relationship to survive past the first few dates. The literature has emphasised oxytocin, often referring to it as the love hormone.

'About 220 million years ago, in conjunction with evolution, that molecule [oxytocin] gave us a whole lot of benefits,' says Sue Carter, a biologist at

Indiana University in the US. It underlies the chemistry of the attachment of a mother with their newborn. 'We have oxytocin, and we have a more primitive molecule, a kind of stress hormone phase suppressant that has many other functions – vasopressin.' Oxytocin and vasopressin work combinatorically and have different receptors but can bind to each other's receptors. Both oxytocin and vasopressin are being released in the falling in love experience, but these chemicals are especially important for staying in love. Oxytocin is responsible for making us feel good when we bond – it is the urge for protection which can be manifested in several ways and while motivations differ, oxytocin is triggered when you feel protected, for example.

Oxytocin is also important for various behaviours not just for pair bonds, but for trust and empathy, and becomes very significant in a 'healthy relationship', says Carter, adding that if vasopressin is the dominant molecule it can result in obsessive, one-sided relationship. The relationship needs to be balanced with a reasonable amount of oxytocin, helping to get the considerable health benefits of good relationships, such as living longer and having less disease. 'In this way oxytocin is our friend but is not sufficient on its own. We have this beautiful chemistry with these two molecules and then a very large arsenal of other chemicals like dopamine, serotonin, opioids etc,' adds Carter.

A recent study looked at prairie voles and found that when removing the oxytocin receptors, they still formed pair bonds so it is possible that oxytocin may not be necessary for pair bonding, but there are very few explicit studies on romantic love and oxytocin. Bode says that while oxytocin makes us feel happy and content when we bond, 'the pleasure we actually gain from these relationships is dictated by opioids'. Endorphin is a natural opioid in the body and is mostly designed to relieve pain but can also be triggered when you laugh. 'There's something called the brain opioid theory of social attachment, which argues that the opioid system is actually the intricate system involved in all sorts of close social relationships,' he adds, stating that endorphins might be better described as the love drug that give us our sense of calmness and pleasure.

Can we fix a broken heart?

Some people call love a drug, and it does work on the same chemistry that other drugs work on. When you take psychedelics, you pour out both serotonin and oxytocin and so the analogies between romantic love and substance dependence are valid. When you're no longer connected to the person you're in love with, you can suffer from withdrawal. 'This

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is a withdrawal system… pretty much identical to the one you see with opioids,' says Carter.

It's so important to form a pair bond for humans that we try to do everything to save that relationship. Dopamine is still a major player in controlling the feelings from a break-up. When a person experiences heartbreak they are overwhelmed by the activation of their dopamine system – they are craving that person. This has been observed in subjects who, after being shown pictures of their ex-partners, had their reward system go into overdrive and so the heartbreak process can be described as a natural addiction. It's the distress area that's active in the brain – we feel the distress of physical pain.

Other behaviours related to threat and fears start to emerge and some individuals can suffer unpleasant physiological symptoms such as depression. While painkillers and antidepressants, particularly selective serotonin reuptake inhibitors (SSRIs), have been shown to relieve some of the grief or feelings of inadequacy, serotonin withdrawal symptoms can happen; 'SSRIs in many people inhibit both emotional behaviours and sexual responses,' warns Carter. Withdrawal from these drugs can have effects of creating a dependency that will later have an impact on the individual's ability to fall in love again.

The disappointment associated with heartbreak is accompanied by a big release of threat chemicals. Stressful moments are associated with elevated cortisol. Cortisol, linked with stress, notifies the brain of a threat – it's released when you fail and tells the brain that your efforts are not getting a reward. During heartbreak you give up on this target and 'it builds a new neural pathway that causes your brain to think negatively about that target instead of positively', says Breuling. This has been seen in studies by Brown. 'When our subjects were looking at this picture of the person who had dumped them, their brains were also trying to - in some of the cognitive areas – weight the negatives and positives…trying to make something better of this.'

However, falling out of love is very different to breaking up. 'You may still feel warmth and friendship towards the person, and you still may love them, but that high isn't there anymore. The activations… tend to be seen in oxytocin- and serotonin-rich regions of the brain, but not necessarily the dopamine-rich areas of the brain,' Acevedo points out, analogous to the brain activity when seeing images of close friends and family.

Hopeful future

Considering how integral love is to our lives, research in the field of romantic love is in its infancy with a lot of uncharted territory in the neuroscience area. Humans are extremely variable, and how much they use the reward system for love and attachment is partly genetic and a lot comes from their experience. The lack of defined parameters for assessment makes this research area challenging yet the potential is huge. Understanding these chemicals and how they relate to different emotional states can allow us to deal with 'broken hearts' at a neurochemical level, as well as accelerating the process of finding love but to date, we know very little about the brain.

Nonetheless, there is strong scientific evidence for the idea of 'chemistry' – 'the brain has told us something about ourselves as humans, it is naturally occurring but a very strong drive…It's not just an emotion that you have control over,' explains Brown, adding that this basic drive for sticking to someone is a part of every human, regardless of their sexual orientation.

There are strong motivations for pursuing the subject as Bode points out. 'Romantic love is the basis for romantic relationship formation and family formation throughout much of the world. And it is something that can bring both great sorrow and great joy. And to that extent, I think it's intrinsically valuable to understand that things that bring us sorrow and joy.'

Chemistry World, 12 February 2024

https://chemistryworld.com

A patch a day? Why the vitamin skin patches spruiked on social media might not be for you

2024-02-24

With patches marketed for sleep, detox, immunity and hangovers, they are being talked up as near magical fix-all stickers. Manufacturers claim they are easy-to-use, convenient and ethical when compared with other types of vitamin products. Some even come with cute floral designs.

So do they work, are they safe, and why would you use one instead of just taking a vitamin tablet?

What are vitamin patches?

Vitamin patches are adhesives designed to deliver vitamins or nutrients to your bloodstream directly through the skin.

Vitamin patches are trending on social media and advertised in posts and podcasts.

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You peel away the backing, place it on a hairless area of skin where it is less likely to be bumped, and then the patches release their vitamins over a period of 12 to 24 hours.

Two dominant brands that market in Australia sell patches that contain various chemical and plant ingredients.

There are patches for menopause symptoms that claim to include plant extracts of gotu kola, damiana, black cohosh, valerian, skull cap, oat seed and ginger. Patches promising an energy boost offer caffeine, taurine, gluconolactone, green tea extract and vitamins B3, B5 and B6.

Do they work and are they safe?

In Australia, vitamins are considered pharmaceutical products and are regulated by the Therapeutic Goods Administration. Vitamins are generally approved as listed medicines, meaning the ingredients have been assessed for safety but not for efficacy (whether they do what they promise).

Being a listed medicine also means vitamins are manufactured in a factory with good manufacturing practices, so you can be assured the ingredients listed on the packaging have been sourced properly and are provided at the correct concentration.

However, there are no items listed as vitamin patches on the Australian Register of Therapeutic Goods. This means they currently can not legally be supplied or purchased in Australia. It doesn't matter if they are being sold from a physical store or online within the country. The TGA won't stop you from buying them from overseas, but they advise you not to do so because you can't be assured of quality and safety.

There is also insufficient evidence that vitamins delivered in this way work. Not all drugs and chemicals can be delivered through the skin. Ordinarily, to be absorbed through the skin a chemical needs to be lipophilic, meaning it likes fats and oils more than water.

So, the form in which the vitamins have been produced and supplied will dictate whether they will get into the skin. For example, a water extract of a plant is less likely to be absorbed when compared with an oil-based extract.

A small 2019 study of patients at risk of nutrient deficiencies after bariatric (weight-loss) surgery gave some of them a daily multivitamin patch for a year. Those patients had lower blood concentrations of several vitamins

and were more likely to have vitamin D deficiency when compared with patients given oral vitamins. The study concluded transdermal vitamin patches were not as effective as oral supplements.

Another issue with vitamin patches is that they contain very low concentrations of ingredients and you may therefore get an ineffective dose, even if all the vitamin in the patch is 100% absorbed through the skin.

For example, one particular patch that is marketed for immunity states that it contains 3 milligrams of vitamin C, which is likely insufficient if taken to supplement a low vitamin C diet. The health condition called scurvy is thought to occur when daily vitamin C intake drops lower than 7 milligrams per day.

In contrast, a typical vitamin C tablet contains 500 milligrams. The recommended daily intake of vitamin C is around 45 milligrams per day – more if a woman is breastfeeding.

Why not just take a tablet?

When other medicines are supplied in a patch formulation it is usually because a constant supply of the drug is needed in the body; think smoking replacement nicotine patches, menopausal hormone therapy and some types of pain relief.

There is no reason why you would need the slow release, continuous supply of vitamins that patches promise – but there may be other reasons to choose them over tablets and gummy products.

One selling point used by the marketers is that patches are a "cleaner" form of vitamins. A vitamin in tablet or gummy form will contain inactive ingredients called excipients. Excipients do various tasks in medicines from binding ingredients together, making the medicine look and smell nice, to ensuring drugs don't break down during storage. The presumption is that patches don't contain and release any, or very few, excipients into your body.

But many patches don't list all their ingredients – just the active vitamins – so this claim can not be tested. Some patches may still contain a large number of excipients, some of which may irritate the skin.

For example, one type of nicotine patch contains 12 excipients including acrylic acid and vinyl acetate, which are chemicals used to help stick the patch to the skin.

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A patch may be worth investigating for people who have trouble swallowing or chewing. In this instance it could be difficult to take a solid tablet or gummy to get your vitamins.

Should you buy them?

As there are no vitamin patches approved by the TGA in Australia, you should not buy them.

If at some point in the future they become listed medicines, it will be important to remember that they may not have been assessed for efficacy.

If you remain curious about vitamin patches, you should discuss them with your doctor or local pharmacist.

The Conversation, 14 February 2024

https://theconversation.com

Plutonium to carbon double bond a first

2024-02-14

Almost 60 years after the first organo–plutonium complex was reported, researchers have prepared the first complex with a plutonium–carbon double bond.

The first organo-plutonium complex (Pu(C5H5)3) was reported in 1965 but research into the fundamental properties of plutonium has been held back due to experimental difficulties and availability of the element. 'Uranium is probably the last element in the periodic table where you can work in a normal laboratory,' explains Steve Liddle, head of inorganic chemistry at the University of Manchester and one of the researchers on the study. 'Go one place to the right and you need a completely different radiological lab setup.'

Liddle explains that due to the paucity of plutonium compounds there has been little opportunity to make experimental comparisons between the trans-uranium elements and the lanthanides but the act of making them, testing them and studying them has enabled them to do just that. 'These are the first double bonds to carbon with a trans-neptunium system, ie plutonium,' he says. 'There's also the first N-heterocyclic carbene–plutonium interactions.'

He says the work has provided an insight into the experimental differences between lanthanides and actinides, in terms of the Wittig chemistry they carried out to make the carbon–carbon double bonds but no such reactivity with lanthanides, and the distinct divergence in their electronic structure.

'It is the generally held view that if you go left to right in the actinide series, the actinides become more lanthanide-like, but this study suggests that plutonium isn't there at that point, you have to go further right. So this is helping people to get a handle on where you are on that scale. But we're seeing real experimental divergence in properties and chemical reactivity between plutonium and analogous lanthanides.'

The Chemistry World, 14 February 2024

https://chemistryworld.com

Lithium-metal battery life extended by an hour's rest

2024-02-08

A team of US researchers has found a simple way to make lithium-metal batteries last longer: discharge them completely, then give them a short rest.

"We were looking for the easiest, cheapest, and fastest way to improve lithium-metal cycling life," says Wenbo Zhang, a PhD student in materials science and engineering at Stanford University, US, and co-lead author on a new paper in Nature.

"We discovered that by resting the battery in the discharged state, lost capacity can be recovered and cycle life increased.

"These improvements can be realised just by reprogramming the battery management software, with no additional cost or changes needed for equipment, materials, or production flow."

Lithium-metal batteries use metallic lithium in their anodes (the part of the battery that supplies electrons) – making them different to lithium-ion batteries, which use lithium-based compounds in battery cathodes (the part of the battery that accepts electrons). By weight, they can hold much more power than lithium-ion batteries.

"A car equipped with a lithium metal battery would have twice the range of a lithium-ion vehicle of equal size – 600 miles per charge versus 300 miles, for example," says co-lead author Philaphon Sayavong, a PhD student in chemistry at Stanford.

Current commercial lithium-metal batteries are mostly single-use only. This is because the lithium metal and other compounds inside the battery react with one another and degrade very quickly when the battery discharges.

Lithium-metal batteries are a promising alternative to lithium-ion batteries. They could be even more energy-dense than lithium-ion, but for now they degrade very quickly, leading to short lifecycles.

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Specifically, tiny bits of lithium get stuck in the electrolyte – the substance which charged particles move through to make electricity flow. The researchers call this a solid electrolyte interphase, or SEI, matrix.

"The SEI matrix is essentially decomposed electrolyte," says Zhang.

"It surrounds isolated pieces of lithium metal stripped from the anode and prevents them from participating in any electrochemical reactions. For that reason, we consider isolated lithium dead."

Researchers have proposed complicated chemical recipes and detailed electrical techniques to stop this degradation.

But previous research from Savayong and colleagues had found that the SEI matrix starts dissolving on its own when the battery is inactive. The researchers decided to investigate this further.

"The first step was to completely discharge the battery so there is zero current running through it," says Zhang.

"Discharging strips all the metallic lithium from the anode, so all you're left with are inactive pieces of isolated lithium surrounded by the SEI matrix."

Then, they let the discharged battery sit.

"We found that if the battery rests in the discharged state for just one hour, some of the SEI matrix surrounding the dead lithium dissolves away," says Sayavong.

"So when you recharge the battery, the dead lithium will reconnect with the anode, because there's less solid mass getting in the way."

This increased the battery's depleted capacity. The researchers used video microscopy to confirm what was going on.

"Previously, we thought that this energy loss was irreversible," says senior author Yi Cui, a professor of materials science at Stanford.

"But our study showed that we can recover lost capacity simply by resting the discharged battery."

Cosmos Magazine, 08 February 2024

https://cosmosmagazine.com

Cancer drug by-product may be an untapped Parkinson's treatment

2024-02-11

After medications are consumed, they're absorbed and distributed around the body. When they've produced their therapeutic effect, they're broken down – metabolized – by various organs into by-products called metabolites, compounds that are more easily eliminated from the body.

The potential therapeutic effects of drug metabolites are often overlooked, even though they are present at high concentrations in the plasma and can be pharmacologically active. However, a new study by the Spanish National Research Council (CSIC) has found that a metabolite produced by the breakdown of a cancer drug may have value as a therapeutic agent in its own right.

Rucaparib, a drug used to treat recurrent ovarian, breast and, more recently, prostate cancers, is broken down to its major metabolite, M324, which can be detected in several species, including mice and humans. M324 can reach higher plasma concentrations in animals than the parent drug and can enter tumor cells; in humans, the metabolite's plasma concentration is around 40% of rucaparib's concentration.

Using four different computational approaches, the researchers comprehensively characterized the profile of M324, enabling them to predict the potential 'off-targets' of rucaparib and its metabolite. They identified targets that were shared by the pair and those that were exclusive to either.

Moving on to experiments on lab cell lines to validate their computational findings, the researchers tested whether M324 had anti-cancer properties. They screened rucaparib and a synthesized version of M324 across a panel of 20 human cancer cell lines that included prostate, breast, ovarian, and pancreatic cancers. In nine cell lines, combining the parent drug and its metabolite increased cancer cell inhibition more than using either compound singly. The biggest difference was seen in the prostate cancer cell line, with a difference in inhibition exceeding 30%.

Having observed synergy but not independent activity in prostate cancer cell line models, the researchers wondered whether the metabolite could, by itself, have activity in another cellular context. Differentiating Parkinson's disease dopamine neurons from induced pluripotent stem cells (iPSCs) obtained from a patient with the condition, they treated the neurons with M324. They found that the metabolite effectively reduced

A new study has found that a compound created by the body's breakdown of a cancer drug has therapeutic properties.

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the accumulation of -synuclein, a protein that, when misfolded into aggregates, causes neuroinflammation, neurodegeneration and cell death. It's been linked genetically and neuropathologically to Parkinson's disease.

The researchers say their findings could have significant clinical impact. First, the synergistic effect seen with rucaparib and M324 could impact clinical trials for advanced stages of prostate cancer, as combining both could be advantageous compared to other cancer drugs used in this setting. It could also have implications for the drug's safety and efficacy and warrants further research. Concerning Parkinson's, the study showed that the metabolite is pharmacologically active and has the potential to be repurposed, representing a new way to treat the disease.

"Overall, we demonstrate that drug metabolites can have a different polypharmacology than their parent drugs, highlighting the importance of making drug metabolites commercially available, incorporating them in preclinical studies, and characterizing them more thoroughly during drug discovery and development to comprehensively understand the effect of drugs in the clinic and better tailor drugs to patients in precision medicine," said the researchers.

The study was published in the journal Cell Chemical Biology.

New Atlas, 11 February 2024

https://newatlas.com

New research reveals mechanisms of stiffening in paper pulp, could lead to improved recyclability

2024-02-13

The work is published in the journal Cellulose.

"Through our studies, we now know at what level of dryness the hornification process begins, already at a dry content of 20 percent," says Björn Sjöstrand, Docent in Chemical Engineering from The Swedish Research Council.

"We also know at what temperatures hornification begins, already at temperatures as low as 40° C, but the biggest changes are seen at temperatures above 100° C. The solvent also plays a role; if we replace the water in the paper pulp with other solvents, it reduces the hornification. This implies that the hydrogen bonds that form in the water environment contribute to the hornification of the fibers."

One of the problems with paper recycling is that the fibers stiffen during the de-watering and drying processes, also known as hornification.

The research findings were presented during Ekmandagarna 2024, an annual conference organized by the Swedish Association of Pulp and Paper Engineers (SPCI). The findings can also be found in several newly published scientific papers.

"It was a great honor to have the opportunity to present our results at this year's Ekmandagarna, which brings together many participants from across the paper industry, both academics and industry representatives. Our hope is that this research can contribute to improved paper recycling where the fibers can be recycled many more times," says Sjöstrand. "In addition, this new knowledge of the hornification process can lead to reduced use of raw materials in paper manufacturing, as it allows for closer control of the durability properties of paper materials."

Greater insight into the process of hornification has many advantages. The research can hopefully contribute to new dewatering processes for the industry, which in turn will create more recycling opportunities and improved product properties.

Paper engineers are hopeful that it will be possible to circulate the fiber up to 25 times, compared to five to seven times today. The most important areas where knowledge of hornification can be applied are market pulp, dry broke, recycling, dissolving pulp and micro- and nano-cellulose applications.

The research provides new insights into hornification, a research area with the potential to provide more opportunities for the forest industry to understand the changes in the binding capacity of wood fibers during the dewatering process. Hornification is when chemical bonds occur inside the fibers.

This prevents the fibers from swelling and reduces their flexibility and external fibrils. Flexible fibers and external fibrils are important for developing strength properties when manufacturing cardboard and paper.

"By using fewer fibers but still retaining the same level of mechanical performance in the products, you get a more optimized utilization of the raw materials," says Sjöstrand. "This means that the results of our project will contribute to both increased recycling and more sustainable use of resources."

Phys Org, 13 February 2024

https://phys.org

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Microscopy method maps chemistry, not just chemicals

2024-01-19

"We made a jump from imaging chemicals to imaging chemistry," says Ji-Xin Cheng of Boston University, who led the research. "Chemical imaging largely maps the presence of chemicals in cells or tissues. We have developed a method to probe the substrate and the product under a high-speed, high-sensitivity vibrational microscope called MIP microscope so that chemistry can be mapped."

MIP microscopy, which stands for mid-infrared photothermal microscopy, uses a visible beam to detect temperature effects caused by IR absorption by specific chemical bonds. Cheng and coworkers designed a new, faster MIP microscope that collects images quickly enough to do real-time imaging in living systems.

The researchers designed probes for imaging enzymatic activity. These three-part probes consist of an enzyme substrate, a nitrile reporter, and a self-assembling moiety. The nitrile reporters undergo spectral shifts between the substrate and the product, leading the researchers to dub the probes "nitrile chameleons." The self-assembling moiety aggregates into nanofibrils that keep the product near the enzyme, which helps map the enzyme location. The signal from the product correlates with the enzyme activity.

The researchers made probes that target caspase-3 and alkaline phosphatase, both of which are involved in cancer biology. The sharp spectral peaks are far enough apart to image the substrates and products for both enzymes at the same time. "There's cooperation between the two enzymes," Cheng says. "This was a hypothesis in the literature for 20 years, but no one can see it. Here we provide visual evidence."

They used MIP microscopy to measure enzyme activity in cancer cells, Caenorhabditis elegans, and mouse brain slices. The approach is as sensitive as fluorescence, Cheng says, and it avoids issues, such as photobleaching, that plague fluorescent dyes.

"Although vibrational probes have been popularly used in Raman microscopy, their use in mid-infrared imaging has been relatively rare," Wei Min, a chemist at Columbia University who develops spectroscopic and microscopic methods for imaging biological molecules in living systems, writes in an email. "Their design of probes is novel in that they made use of aggregates in order to amplify the signal. Although the chemistry is

A new microscopy method enables researchers to visualize the activity of the enzymes caspase-3 and alkaline phosphatase in various biological samples (Nat. Methods 2024, DOI: 10.1038/s41592-023-02137-x) .

perhaps more involved compared to simple isolated molecules, the end result appears to justify the means."

Cheng envisions eventually being able to use the approach to image multiple enzymes involved in cellular processes such as apoptosis. "The challenge is how to design these probes so they have different peak positions, and you can monitor them inside the same cell."

C&EN, 19 January 2024

https://cen.acs.org

Novel coating repels limescale to improve thermal power plant efficiency

2024-02-11

Mainly consisting of calcium carbonate, limescale buildup can be seen around the home, on the inside of kettles, water tanks and washing machines, especially in areas where the water is hard – that is, high in mineral content – and when the surfaces come into contact with hot water.

While it's a nuisance at home, limescale buildup has a greater impact on thermal power plants. These plants use boilers to heat water, producing high-pressure steam that drives a turbine to produce mechanical energy that's converted into electrical energy by a generator. Industrial heat exchangers and membranes are prone to limescale buildup, causing an enormous energy loss – at least 2% of the total world energy production per year – due to reduced heat transfer and flow performance efficiency.

To address this issue, researchers from ETH Zurich in Switzerland and the University of California, Berkley have collaborated to develop an innovative hydrogel-based surface coating that repels limescale and prevents it from adhering.

The researchers started by examining individual limescale crystals and surrounding water flow at the microscopic level to see how the crystals deposit and adhere in dynamic aqueous environments. They then set about developing several coatings from soft materials and tested them in the lab.

Experimenting primarily with different polymer contents, the researchers found that the lower the polymer content and the higher the water content, the less well the calcium carbonate crystals adhered to the surface, which they'd fabricated to include tiny ridges. The researchers

Limescale buildup in thermal power plants due to the use of hot water can substantially affect efficiency, prompting researchers to develop a novel soft hydrogel-based surface coating that repels limescale crystals and prevents them from adhering.

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drew inspiration for their design from nature, particularly the ridges on a shark's skin, which makes it very hard for microbes to attach.

Tests using model particles made of polystyrene demonstrated that the surface ridges needed to be smaller than the particles deposited on them to reduce the contact surface and, thus, the resultant adhesive force.

"We varied the material's surface to achieve the greatest efficiency, then carried out the crystal experiments with the optimum structure size," said Julian Schmid, the study's lead author.

Moving to experiments with limescale crystals, the researchers found that when water flowed across the soft hydrogel-coated surface, up to 98% of the crystals, with a size of around 10 micrometers, were removed. This was 66% better than using a rigid, untreated substrate under the same conditions.

Currently, toxic chemicals are sometimes used to remove limescale from heat exchangers and membranes. The researchers say their novel surface coating is more eco-friendly and efficient than current approaches. In addition, they expect their solution to be scalable.

Rather than patenting their approach, the researchers decided to publish their study findings so that other interested parties can use and further develop the novel coating.

The study was published in the journal Science Advances.

New Atlas, 11 February 2024

https://newatlas.com

Researchers use mussel-derived proteins to develop customized underwater bio-adhesive patches

2024-02-13

Professor Hyung Joon Cha from Pohang University of Science and Technology (POSTECH), along with Ph.D. candidate Jang Woo Yang (POSTECH), senior researcher Hwa Hui Shin (K-MEDI Hub), and Professor Kang-Il Song (PKNU), have garnered attention by using mussel-derived adhesive proteins to develop customized underwater bio-adhesive patches (CUBAP). Their research is published in the journal Advanced Materials.

The field of adhesives is diverse, catering to a wide range of applications from everyday uses like paper and fabric to specialized ones like woodwork.

These patches are crucial in effectively sealing internal wounds, leaks, and perforations in the body's organs, aiding in healing and tissue regeneration. As research in internal transplant devices expands, there is a growing need for adhesives that can securely hold these devices in place.

The biomedical adhesives used in such applications need to maintain strong adhesion underwater while minimizing side effects. The ability to customize features like biodegradation time is also essential, considering the unique biological environments of different organs.

Professor Hyung Joon Cha's research team members, pioneers in applying mussel adhesive proteins for medical adhesives, have taken a step further with the development of CUBAP.

This adhesive is not only excellent in underwater adhesion but is also made from natural materials, ensuring safety and biocompatibility within the human body. The team has produced customized patches (CUBAP) by combining mussel adhesive protein with polyacrylic acid and polymethacrylic acid, and these are currently undergoing clinical evaluation for minimizing scarring in skin closures.

In its dry state, the patch is non-adhesive, but in the human body or other humid environments, it exhibits strong adhesive properties. Furthermore, researchers can control the degradation time and mechanical hardness by adjusting the polyacrylic acid and polymethacrylic acid ratios. This enables a customized adhesive system, considering the diverse structural and biological needs of different organs.

The research team created three types of customized adhesive patches and applied them in animal treatments and implants. These patches maintained high adhesion even in highly mobile organs such as the heart and bladder. They also conducted successful experiments in adjusting biodegradation times and flexibility during the transplantation of muscle regeneration electronic devices.

Professor Cha, the senior researcher, said, "This research paves the way for personalized medical applications. We plan to enhance and refine the process through subsequent studies, with the goal of effective applications in diverse biomedical fields."

Senior Researcher Hwa Hui Shin from K-MEDI Hub said, "Our study has confirmed the effectiveness and versatility of the developed bio-adhesive

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patches. We look forward to their evolving into commercial products, meeting the demands of the health care sector."

Phys Org, 13 February 2024

https://phys.org

Half of U.S. Tap Water Tainted by "Forever Chemicals" – Breakthrough Detection Method Acts in Minutes

2024-02-13

PFAS have earned the name "forever chemicals" with good reason — the man-made compounds, which can take thousands of years to degrade and are found in everything from grease-resistant food packaging to water-repellent clothing, have made their way into nearly half the U.S. tap water supply.

Now, in a study featured in Elsevier's Journal of Hazardous Materials, New Jersey Institute of Technology chemists have demonstrated a new lab-based method to detect traces of PFAS from food packaging material, water, and soil samples in just three minutes or less.

Researchers say their approach could significantly speed up efforts to study and address the bioaccumulation of PFAS in the environment, including more than $2 billion of EPA grant funding from President Biden's Bipartisan Infrastructure Law for states to conduct water quality testing and treatment for the emerging contaminants.

"There are thousands of different species of PFAS, but we've yet to understand the extent of their distribution in our environment because the current testing methods are costly and time-consuming, taking hours for sample preparation and analysis in some cases," said Hao Chen, the study's corresponding author, and NJIT chemistry professor. "What our study demonstrates is a much faster, sensitive, and versatile method that can monitor our drinking water, land, and consumer products for contamination in minutes."

Enhancing PFAS Detection Techniques

Chen and colleagues say the new method — involving an ionization technique for analyzing the molecular composition of sample materials called paper spray mass spectrometry (PS-MS) — is 10-100 times more sensitive than the current standard technique for PFAS testing, liquid chromatography/mass spectrometry.

Researchers report one of the fastest and most sensitive approaches yet for detecting toxic per- and poly-fluoroalkyl substances (PFAS) accumulating in the environment, which are linked to health risks ranging from cancers to birth defects.

"PFAS can be ionized and rapidly detected by a high-resolution mass spectrometer, which gives a clear view of each PFAS species present and the degree of contamination down to a parts-per-trillion (ppt) level," explained Chen. "For more complex matrices like soil, we've applied a related method called desalting paper spray mass spectrometry (DPS-MS) that washes away salts which normally suppress the ion signal of PFAS. Together, they greatly improve our ability to detect these compounds."

"Our limit of detection for PFAS is roughly 1ppt. For context, this amount has been likened to a drop of water in 20 Olympic-sized swimming pools," added Md Tanim-Al Hassan, the paper's first author and Ph.D. chemistry student at NJIT.

Practical Applications and Future Implications

In tests, the team was able to detect PFAS in one minute or less by analyzing pieces of various food packaging materials directly, including microwave popcorn paper, instant noodle boxes, as well as fry and burger packaging from two multinational fast food restaurant chains.

The analysis revealed traces of 11 different PFAS molecules — including common types that have been linked to increased cancer risk and immune system suppression, such PFOA (Perfluorooctanoic Acid) and PFOS (Perfluorooctanesulfonic acid).

In their water analysis, the team detected traces of PFOA in samples of local tap water in under two minutes, while finding no traces of PFAS in samples taken from the university's filtered fountain water.

"The EPA has already proposed to establish maximum contamination levels (MCLs) for six PFAS in drinking water nationwide, and PFOA and PFOS are among them," said Mengyan Li, study co-author and NJIT associate professor of environmental sciences. "This analytical method could facilitate more intensive screenings for toxic PFAS that may be needed under such a proposal to protect the safety of our water supply."

Using DPS-MS, the team also identified two species of PFAS from as little as 40mg of soil in under three minutes.

Already, the team's rapid detection method is being tested for use alongside cutting-edge techniques for remediating PFAS that are being developed at NJIT's BioSMART Center.

"Remarkably, in our lab, we were able to couple this analytical method to a novel degradation catalyst, which degrades 98.7% of PFAS in drinking

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water samples within three hours," said Wunmi Sadik, study co-author and chair of NJIT's Department of Chemistry and Environmental Sciences. "This work may have a national impact, but the immediate effect will be felt in the Northeast area. Roughly 10% of 9.2 million New Jersians have high levels of perfluorooctanoic acid in their drinking water compared to the national average of 1.9%."

Chen says the advance could also have a swift impact on the monitoring of consumer products, from cosmetics and medicine to fresh and processed foods. The team plans to demonstrate the method's capabilities for air monitoring as well.

"Near term, this could be extremely useful for ensuring the safety of food products … it may allow farming produce to be more efficiently monitored for PFAS contamination for example," explained Chen. "Our method may also advance the study of airborne PFAS in a similar way to what we've demonstrated in this study, which would further help us address this widespread environmental issue."

Sci Tech Daily, 13 February 2024

https://scitechdaily.com

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The potential health risks of N,N-dimethylformamide: An updated review

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Linking antibiotic resistance gene patterns with advanced faecal pollution assessment and environmental key parameters along 2300 km of the Danube River

Dust-phase phthalates in university dormitories in Beijing, China: pollution characteristics, potential sources, and non-dietary oral exposure

Microplastic contamination in the agricultural soil-mitigation strategies, heavy metals contamination, and impact on human health: a review

PHARMACEUTICAL/TOXICOLOGY

Occupational asbestos exposure and risk of esophageal cancer: A systematic review and meta-analysis

Environmental chemical TCPOBOP exposure alters milk liposomes and offspring growth trajectories in mice

Long-term cadmium exposure induces epithelial-mesenchymal transition in breast cancer cells by activating CYP1B1-mediated glutamine metabolic reprogramming in BT474 cells and MMTV-Erbb2 mice

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Effects of wearing medical gowns at different temperatures on the physiological responses of female healthcare workers during the COVID-19 Pandemic

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