

Technology scan

Innovative Technologies for Air Pollution Control

USA

Plant-based Disinfectant

The Clorox Company (NYSE: CLX) was named a winner of the Environmental Protection Agency's (EPA) 2023 Green Chemistry Awards for its efforts to design products that reduce the generation and use of hazardous substances. The company was distinctly recognized in the "Designing Greener Chemicals" category for its development and launch of Clorox EcoClean™ Disinfecting Cleaner, which is made with a plant-based active ingredient that kills 99.9% of illness-causing germs in two minutes or less when used as directed.

The Clorox Company (NYSE: CLX) champions people to be well and thrive every single day. Headquartered in Oakland, California, since 1913, Clorox was one of the first U.S. companies to integrate ESG into its business reporting.

Ingredient advocacy is a critical element of Clorox's environmental, social, and governance goals, which are embedded in the company's corporate IGNITE strategy. The Clorox EcoClean™ product line, sold via the Clorox Professional business unit, includes All-Purpose Cleaner and Glass Cleaner in addition to Disinfecting Cleaner. Clorox EcoClean™ helps the company deliver on its promise to enhance the sustainability of its products via the use of plant-based ingredient alternatives and to reduce virgin plastic in its supply chain by using a minimum of 25% post-recycled plastic in packaging.

This recognition builds upon Clorox's longstanding product stewardship efforts, which include becoming the first major consumer packaged goods company to voluntarily disclose ingredients in U.S. retail and professional cleaning, disinfecting, and laundry products over a decade ago. Clorox was also recently named an EPA 2023 Safer Choice Partner of the Year for its outstanding achievement in the manufacturing of products with ingredients that are safer for families, pets, workplaces, communities, and the environment.

EPA's Green Chemistry Challenge Awards: Since the inception of the awards more than a quarter century ago, EPA and the American Chemical Society, which co-sponsor the awards, have received more than 1,800 nominations and presented awards to 133 technologies that decrease hazardous chemicals and resources, reduce costs, protect public health, and spur economic growth. Winning technologies are responsible for reducing the use or generation of hundreds of millions of pounds of hazardous chemicals, saving billions of gallons of water, and eliminating billions of pounds of carbon dioxide equivalents annually.

<https://www.prnewswire.com>

Aclima: Hyperlocal Air Pollution Monitoring

Fine particles enter the air from a wide range of sources, such as energy production, industry, transport, agriculture, waste, forest fires, and households, causing air pollution. These particles linger in the air for long periods and can be transported long distances. Particles that measure less than 2.5 µm in diameter are particularly concerning for public and environmental health. Greenhouse gas pollutants also significantly contribute to air pollution. There is a vast body of research that connects exposure to air pollution (both short-term and long-term) with adverse health outcomes.

It is well-known that exposure to air pollution increases the risk of many diseases, including respiratory illnesses, cardiovascular illnesses, neurovascular diseases, and cancer (including lung cancer).

It is also recognized that air pollution can exacerbate the symptoms of those who are already ill. It is estimated that around one-third of deaths caused by stroke, heart disease, and lung cancer are due to air pollution exposure. In Europe, air pollution is the single largest environmental health risk and one of the greatest causes of premature death and disease.

Increasing evidence reveals the link between air pollution and health outcomes for babies. Studies have shown that exposure to high levels of air pollution may reduce lung function development. Research has discovered that air pollution particles are present in babies' lungs as early as the first trimester. Air pollution has also been linked to an increased risk of preterm birth and low birth weight.

Air pollution has also been linked to an increased risk of mental illness. There is growing evidence to support the link between exposure to air pollution and mental health problems such as depression and anxiety. Research has also exposed a link between air pollution and psychiatric disorders such as schizophrenia.

Unfortunately, almost every inhabitant (99% of the global population) is exposed to air that contains pollutants that exceed what is deemed safe by the WHO. Therefore, it is essential to monitor air pollution to help fight it. Monitoring levels of air pollution is vital to understanding its role in influencing human health. It also highlights regions that are most intensely plagued by dangerous air pollutants. Furthermore, it can give insight into how initiatives to reduce air pollution are working, which is important for guiding future initiatives and maximizing their efficacy.

Aclima, a US-based technology company that seeks to protect public health, reduce emissions, and deliver clean air, has established the world's most advanced air measurement and analysis platform to monitor air pollution. Its technology, which leverages hyperlocal data, is an important tool for fighting against air pollution.

Aclima has developed air pollution monitoring technology that maps and analyzes air pollution and greenhouse gases unprecedentedly. Aclima's solution is based on a complex network of sensors, both stationary and roving, that collects fine-grain information on the nature of air pollution in different neighborhoods. The technology gathers pollutant measurements with block-by-block resolution, helping

to highlight air pollution disparities and identify areas most in need of intervention.

Specialized sensors are employed to collect measurements each second from the global mapping fleet, either from stationary locations or on the move. Routing software ensures that data collected from these sensors is scientifically robust. Community members are hired into full-time paid positions to run and maintain the network so that this fine-grain data can be collected around the clock.

As a result, Aclima's solution allows us to understand air pollution at the human scale. Its innovative network of sensors provides as much as 100,000x greater resolution information collected by traditional air pollution monitoring platforms. The solution is also able to track multiple pollutants simultaneously using chemical fingerprinting. This technology makes it the only platform to measure and analyze air pollution, greenhouse gases, and toxins at the same time.

Aclima's sensor technology allows air pollution information to be gathered from urban, suburban, and rural landscapes, offering a solution that works for all geographic types. With the widespread adoption of the platform, entire cities/states/regions and even countries could pool together their information to understand air pollution at an unprecedented level.

Notably, the platform developed by Aclima answers essential questions about air pollution at the neighborhood block level. In doing so, it gives decision-makers critical insights as to where and when air pollution is most dangerous. It also highlights who is at maximum risk. This information may reveal that air pollution is particularly high when people are commuting to work. If there are congested roads along schools, this could mean that young children are being exposed to dangerous levels of air pollution on their walk to school. Having real data to expose these dangers is important to influence decision-makers to make critical changes, such as pedestrianization, that could improve the health outcomes of those at risk. For example, Aclima has already been used

to expose air disparities in the Bay Area, which may lead to a positive change and reduce air pollution in key areas.

The technology offered by Aclima collects hyperlocal data, which can play an important role in tackling air pollution on a large scale. Policymakers need to see real data on air pollution to make changes. Sensor technology can expose areas at the block level that are particularly at risk of air pollution and even reveal the times of day when air pollution is at its worst. This enables experts to understand the factors that contribute to air pollution, such as rush hour traffic, and protect the most vulnerable, such as young children whose schools are close to congested areas.

A wider adoption of sensor technology so that air pollution can be better monitored would allow for well-designed interventions. Other global experts in sensor technology are likely to improve on the currently available technology so that it is even more fine-grained and actionable. Overall, sensor technology will play a key role in emissions reduction.

<https://www.azocleantech.com>

Sensor-Equipped Google Street View Cars Prove Adept at Sniffing Out "Hyperlocal" Pollution Sources

Researchers from the Universities of Utah and California at Riverside have experimented with tracking down "hyperlocal" sources of airborne pollution by equipping Google Street View cars with sensors.

With mobile vehicles, you can send them anywhere they can drive to map out pollution, including sources that are off the road.

The core concept behind the project is simple: fixed-position monitoring systems can provide an overview of air quality, but only across a relatively wide area. By equipping vehicles with the same technology, it is possible to gather data over a much wider area and model the results to find the sources of pollution, even when they occur off-road.

The team launched trials in 2019, partnering with Google to add air quality sensors to a pair of Street View cars – vehicles that were always on the road and visited large areas, taking images for the company's mapping service. The data thus gathered showed expected spikes in pollutant levels along highways. At the same time, a new atmospheric modeling method proposed by Lin confirmed pollution from two known sources as well as a previously unknown source in an industrial area near Salt Lake City airport.

The learning is that there is a lot of spatial variability of air pollution from one end of a block to another. There can be a big difference in what people are breathing, and this scale is not captured by the typical regulatory monitors and the policy that the US EPA uses to control air pollution.

There is a need to understand what average air pollution looks like in different communities and then understand the causes of its variability and hotspots to determine what we can do about it. The team's work has been published in the journal *Atmospheric Environment* under open-access terms.

<https://www.hackster.io>

SWITZERLAND Air Capture Tech to Offset Carbon Emissions

Solving the climate crisis would require a level of global cooperation that has never been achievable in human history. Climeworks is a company providing a unique solution to a complex issue and one of many technological solutions being explored across the world. This Swiss company was set up by two mechanical engineers in 2009. Dr. Christoph Gebald and Dr. Jan Wurzbacher pooled their knowledge and created the world's first industry-scalable direct air capture facility based in Iceland. Partnering with Carbfix, Orca essentially sucks carbon dioxide right out of the air and stores it in underground deposits where it cannot contribute to global warming and the chaotic climate fluctuations that come

with it. The technology is called direct air capture and storage (DAC+S).

Climeworks' efforts are not intended to replace global reductions in emissions but focus on removing historical emissions already present in the atmosphere. Orca's direct air capture and storage (DAC+S) can run 24/7, largely autonomously, save for a small crew with maintenance considerations. The Orca plant was designed as something of a "proof of concept" and is the basis for a vast expansion.

The Orca plant is impressive to behold. The footprint of the plant is less than half an acre, making it a thousand times more effective than tree planting, which is often touted as an alternative to reducing emissions. The Orca plant can absorb 4,000 tons of carbon dioxide from the atmosphere every year. If replaced with trees, the same land area would only absorb around 4.7 tons of carbon dioxide per year. Trees also release much of the carbon they store when they die.

Iceland has a unique and dramatic landscape. Iceland, a relatively young island, millions of years old rather than hundreds of millions, has huge plains of volcanic stone that are quite remarkably bereft of trees. For a fraction of the space, Climeworks' systems use gigantic fans with a modular, stackable design to absorb air, linked up to a filter that collects carbon dioxide. Once full, the system heats up to boiling point and combines the particles with water, pushing the mixture into the earth's crust. There, the carbon remains trapped and mineralized for anywhere up to 10,000 years. It is a particularly exciting solution that, even in its infancy, has the potential to become incredibly scalable.

Sitting between tectonic plates, Iceland offers unique geography and abundance of space, coupled with the presence of geothermal energy, making DAC+S plants a lucrative investment area for the region.

Companies like Microsoft are seeking to account for decades of carbon emissions. Some companies are less concerned than

others, but Microsoft seems to be putting its money where its mouth is despite being criticized for its more recent boost in water and energy usage for AI push.

For Climeworks and similar companies, the business model revolves around selling carbon credits, occasionally called carbon offsets. Climeworks charges roughly 1000 euros per ton of carbon stored by its system, and Microsoft is one of its customers. A third party verifies Climeworks' operations to ensure the validity of those credits, and Microsoft and other companies can purchase those carbon dioxide tons in advance, before the system scales up. And scaling up is exactly what is next for Climeworks.

Orca serves as the blueprint for Mammoth, Climeworks' next major DAC+S facility, built a few hundred meters away from the original Orca site. Mammoth will remove up to 36,000 tons of carbon dioxide from the atmosphere once fully operational in the coming years.

<https://www.windowcentral.com>

FRANCE

Aeroleaf to power homes

A new technology can help the European Union (EU) achieve carbon neutrality. Aeroleaf, a French company created by New World Wind, has developed micro wind turbines designed to resemble trees.

The technology, named WindTrees, comprises metallic structures designed to mimic trees, equipped with branches and adorned with small wind turbines that resemble leaves.

The WindTrees technology has been installed globally, including in Europe, the US, South Korea, and specific locations like Birmingham (UK), Vermont (USA), and Switzerland.

Furthermore, the color of the trunk and leaves is customizable. There are additional features, including trees ranging from 5 to 33 feet (10 meters) in height. They facilitate straightforward installation, even in urban settings, without the need for extensive engineering efforts.

Once a turbine is positioned, completing the construction requires just a single bracket and three bolts. Additionally, their smaller size mitigates certain challenges encountered by larger turbines, such as bird collisions; they also operate silently.

Such features offer several advantages, including a biomorphic appearance that blends with surroundings, ease of installation (requiring only a single bracket and three bolts), and compact size.

The technology allows small-scale wind turbines to supply energy directly to the existing electrical system of a building, adhering to a self-consumption model. These turbines are capable of producing energy continuously, 24/7, and any surplus energy can be stored in batteries with a capacity of 60Ah.

The company plans to unveil a new design, which aims to triple the power output of the Aeroleaf, by January 2024.

Each leaf will have the capacity to generate up to 1,000 kilowatt-hours (kWh) per year. Consequently, the 36-leaf WindTree is projected to achieve a maximum annual output of 36,000 kWh when exposed to a wind speed of 39 feet (12 meters) per second (m/s). However, since the wind is unlikely to stay high at all times, even under typical conditions of 26 feet (eight meters) per second (m/s), a single WindTree can generate nearly 18,000 kWh annually.

This amount of energy is sufficient to power a household with four residents and has the potential to decrease the home's yearly CO₂ emissions by more than 12 tons. If excessive energy was generated beyond consumption needs, whether during the day or night, it could be stored in the battery with a capacity of 60Ah, equivalent to approximately 45 minutes to one hour under normal conditions. Each tree is equipped with four batteries. The company has deployed 130 units worldwide, spanning regions from Europe and the United States to South Korea.

<https://interestingengineering.com/>

INDIA

Chakr innovation for mitigating vehicular Air Pollution

Chakr Innovation is a registered company that develops innovations to reduce emissions that contribute to air pollution. As an engineering student at IIT-Delhi, Kushagra Srivastava, with the help of his faculty members, got exposure to various expert committees and panels working with the government to tackle the air pollution issue. He spent the next 2.5 years in research and development; in 2019, the product was ready for commercialization. Chakr, developed by Srivastava, is the world's first retro fit emission control device (RECD) for diesel generators. The Chakr Sheild, a patented technology, reportedly captures over 70 percent of particulate matter emissions from the exhaust of diesel generators.

The technology has been deployed at over 1,000 locations, and the company has more than 150 customers. These include Reliance Industries, the Tata group, ITC, Amazon, and the Coca-Cola Company, among others. So far, over 40,000 metric tons of carbon dioxide have been prevented from going out into the air by deploying this emission control technology at various locations.

The retrofit emission control device has received approval from the Central Pollution Control Board (CPCB). Anyone else entering the sector will have to incur a significant amount of capital expenditure and conduct hours of testing on the devices with the accredited government labs to get these approvals. Chakr started with one product at the time of their investment and wanted to become a multi-product company.

The startup has raised about \$22 million (close to Rs162 crore) in funding and has developed other technologies that have been commercialized, while two others are in the research and development (R&D) stage.

Their diesel fuel kit enables a diesel engine to run on a mix of gas and diesel. It uses 70

percent gas and 30 percent diesel, which reduces emissions. Another innovation that has been in the works for the past three years is an indigenous energy storage technology that may reduce India's dependence on lithium-ion, which is currently the default energy storage solution. As of now, India relies heavily on China and Hong Kong for its lithium requirements.

Chakr's aluminum-based indigenous energy storage technology has an initial capex that is 40 percent less than that of lithium-ion, and the operational expense is 30 percent less than that of an internal combustion engine. This energy storage technology is recyclable, unlike lithium-ion batteries, which need to be disposed of. In electric vehicles, this indigenous storage tech will be non-flammable (unlike lithium-ion), have three times the range, and generate zero waste.

The cleantech startup is also developing a software platform for connecting decentralized sources of energy, which is in the R&D stage. Srivastava claims that Chakr is a profitable company, with average revenues of over Rs10 crore a month. As an investor, Panth expects the company to perform strongly and feels that there are strong commercialization prospects for the solutions that are currently in development.

<https://www.forbesindia.com>

Data Science, IoT-based Method for Mobile Pollution Monitoring

Researchers at the Indian Institute of Technology Madras (IIT Madras) have recently developed a low-cost mobile air pollution monitoring framework in which pollution sensors mounted on public vehicles can dynamically monitor the air quality of an extended area at high spatial and temporal resolution. Traditionally, ambient air quality is measured in monitoring stations and reported by the 'Air Quality Index' (AQI). Since these stations are at fixed locations, they only measure the air quality of a small geographic area.

Air pollution, however, is dynamic, with locations just a few hundred meters away from each other exhibiting different levels

of pollution. Levels can also vary at different times of the day. However, setting up more stations is not practical because of the high costs.

To tackle this issue, IIT Madras researchers have developed a new IoT-based mobile air pollution monitoring technology wherein low-cost air quality sensors are mounted on vehicles to gather spatio-temporal air quality data. For the cost of a single reference monitoring station, it would be possible to map an entire city at high resolution using these low-cost mobile monitoring devices.

Led by professor Raghunathan Rengaswamy, Dean (Global Engagement) and Faculty, Department of Chemical Engineering, IIT Madras, Project Kaatru (air in Tamil) leverages IoT, big data, and data science to achieve the following goals:

In an interesting observation, one specific location showed a significant spike in PM2.5 pollution between 2 am and 3 am. This was associated with trucks carrying milk from a major milk distribution hub in this location at that time. PM2.5 spikes were also found in school neighborhoods during the start and end of school hours and in commercial zones during peak hours.

Mobile air quality sensors will find extensive use in both personal and public health initiatives. Personal monitoring devices can help people know the extent of pollution in their neighborhood so that they can take protective measures. Traffic can be rerouted if local pollution levels are known. Government policy changes and smart city planning would benefit enormously from the use of mobile air quality trackers.

Our affordable IoT-based mobile monitoring network, coupled with data science principles, offers an unprecedented advantage in gathering hyperlocal insights into air quality. It is the only viable option at present, capable of offering high spatio-temporal awareness that could allow for informed mitigation and policy decisions.

The devices can measure multiple parameters, ranging from PM1, PM2.5, and PM10, and gases such as NOx and SOx.

In addition to pollutants, the devices can assess road roughness, potholes, and UV index, among others. The device's modular design allows for sensors to be replaced on demand.

<https://www.indiatoday.in>

Air Quality Monitoring for Steel Industries

Oizom, an Air Quality Monitoring company from Ahmedabad, is providing an innovative solution for air quality monitoring in the steel industry. The steel industry generates large amounts of air pollution, including harmful gases like sulfur dioxide and nitrogen oxide, through the traditional blast furnace process. The solution is designed to help the steel industry comply with environmental regulations as well as minimize the impact of their operations on the environment and local communities.

Oizom smart air quality monitors are built with robust sensors, data analytics, and cloud-based software to provide real-time information on air quality. These monitors provide companies with accurate insights to take precautionary actions and stay within environmental regulatory limits.

The auto alert feature enables the maintenance crew to take immediate action when pollution threshold limits are breached. The relay-based systems also enable the automation of mitigation systems like scrubbers and purifiers. With Oizom's EHS air monitoring, steel companies can ensure that their employees are safe from any health hazards caused by dust.

The steel industry is among the top 17 industries responsible for massive emissions of pollutants in the environment. Thus, it is crucial to find a way by which steel companies can monitor air pollution and take preventive steps. The multiparameter air quality monitors provide real-time data and accurate insights, allowing companies to make informed decisions to minimize their negative impact and improve their sustainability.

Oizom's solution has been adopted by some of the leading steel companies in India and across the globe.

The calibrated and robust air quality monitors help mitigate the causes of excess dust, saving steel plant owners from significant penalties for exceeding the limits of air pollution. Thus, by providing real-time data and insights even in extreme climatic conditions, Oizom is enabling companies to stay compliant and demonstrate their commitment to reducing air pollution and taking care of their employees.

Oizom offers cutting-edge air quality monitoring devices with accurate data analytics to provide real-time data, smart alerts and notifications and support informed decision-making in various industries. The company's solutions have been adopted by leading organizations, helping companies prevent excessive air pollution and improve their overall sustainability. Oizom's mission is to help companies take proactive steps towards a cleaner and greener future.

<https://www.prnewswire.com>

Pulsed Wifi Technology for Air Pollution Control in Heavy Industries

Devic Earth provides plug-and-play air pollution control equipment for heavy industries, factories, businesses, and outdoor spaces. Devic Earth's flagship product, Pure Skies, works on Pulsed WiFi technology and covers large areas — both indoors and outdoors — with cost-effectiveness. Rapid pulses originate from the device in the Wi-Fi frequency band, creating a temporary charge on microscopic pollutant particles (PM2.5 and PM10) present in the air. Due to the increased charge, the natural process of agglomeration and settling of pollutant particles (known as dry deposition) is accelerated. The air quality index typically improves by 50-90 percent outdoors. Pure Skies is backed by 13 years of research and development (R&D) and is third-party-certified for efficacy and safety.

The motto is to offer a technological intervention that would be safe and effective and cover large areas at a low cost.

Customer feedback at Devic Earth ranges from healthier employees who apply for fewer sick leaves to happier customers. All of these account for cost-saving measures on the company's part, depending on the company's size.

The important feature of Devic Earth's product is that it is able to cover large areas. The team learned that they needed to take technology to the people who are worst affected, so they focused on the heavy industries — steel, cement, mines, and power plants. Owing to the increased emphasis on the United Nations (UN) Sustainable Development Goals (SDGs), every company is more willing to prove its eco-friendly credentials in operations and practices. The company is also focusing on business-to-government (B2G), having already engineered a number of efficient pilot projects in collaboration with government outfits, while others are currently under commercial discussions.

<https://yourstory.com>

SERBIA Liquid Tree

Liquid Trees is a new creation that could potentially replace the traditional trees in urban areas. The concept involves a tank filled with water and microalgae that can absorb carbon dioxide and release oxygen into the atmosphere. The microalgae also absorb pollutants, making the air cleaner and fresher.

The idea for this innovation has come from Serbian scientists. Dr Ivan Spasojevic, a Biophysical Science Ph.D. and one of the authors of the project at the University of Belgrade, has developed an amazing new tool to combat greenhouse gas emissions and improve air quality: the liquid tree, or LIQUID 3 for short.

According to World Bio Markets Insights, this revolutionary urban photo-bioreactor, the first of its kind in Serbia, utilizes

microalgae to bind carbon dioxide and produce oxygen through photosynthesis. It is a fantastic replacement for trees or lawns, as it is 10 to 50 times more efficient at reducing carbon emissions. The goal of LIQUID 3 is to be of use in urban areas where planting trees is not feasible. In polluted areas such as Belgrade, trees often cannot survive, but algae can thrive.

The reactions to Liquid Trees have been mixed. Most people believe that trees provide more to an urban area than just being a “living thing” and offer benefits such as shade, decoration, traffic calming, and supporting biodiversity. Others are completely thrilled and have expressed their excitement about this new development.

<https://www.news18.com>

GERMANY

Air Quality Monitoring System Harnessing AI Technology

DEUS Pollutrack is an IoT solution platform for monitoring air pollution and emissions. They are proud to operate Europe's largest connected environmental data platform, utilizing over 4000 mobile sensors to measure air quality for over 45 million citizens in 30 major European cities.

DEUS Pollutrack has engineered a breakthrough IoT system to effectively monitor air pollution factors and greenhouse gases (GHGs) such as CH₄, CO₂, particulate matter (PM 1, PM2.5, PM10), VOCs, and NO_x. Their customers benefit from the unique modular and customizable sensor monitoring systems that can effortlessly be deployed and expanded with additional sensors. The installation process is designed to be user-friendly and requires no technical knowledge, optimizing both time and cost for DEUS's customers.

The new EU methane regulation requires the oil, gas, and coal sectors to measure, report, and verify methane emissions to the highest standards. Operators must measure and report methane emissions continuously in ambient air and surface

areas, which are then verified by independent accredited auditors. For this application, the DEUS Pollutrack system offers unsurpassed precision (from 0.1ppm) with a lifetime of 7 years per sensor. This provides the industry with a truly powerful tool for continuously monitoring methane emissions.

DEUS Pollutrack leverages laser-based techniques to identify leaks, enabling fast and efficient repairs. This proactive approach significantly reduces emissions, minimizes wasted resources, and improves operational efficiency. Advanced sensors, data analytics, and artificial intelligence can significantly improve the accuracy and efficiency of leak detection systems. The data collected in real time is invaluable to the industry in creating comprehensive sustainability reports. Moreover, DEUS Pollutrack's seamless continuous monitoring enables oil and gas operators to achieve Level 5 of the OGMP 2.0 Gold Standard.

DEUS Pollutrack leverages AI to provide a scalable and customizable innovative dashboard tailored to meeting their customers' specific needs and enhancing user-friendliness. Their comprehensive support includes installation planning, data analysis, evaluation, and expert consulting. DEUS provides actionable emission mitigation strategies and ensures its customers receive extensive support and guidance to create seamless, data-driven sustainability reports. This will revolutionize emissions monitoring and greatly assist the industry in achieving its sustainability responsibilities.

<https://www.envirotech-online.com>

UNITED KINGDOM

Breathe London: technology supported grassroots Clean Air Movement

London has battled poor air quality for centuries, with records of deadly air pollution events dating back to the 13th century. Major smogs in the 1940s and 1950s led to

the implementation of the UK's Clean Air Act in 1956. But while air quality improved dramatically, London still exceeds World Health Organization limits for key pollutants like nitrogen dioxide (NO₂) and fine particulate matter (PM_{2.5}).

Recent research indicates that in 2019 alone, air pollution contributed to the equivalent of more than 4,000 early deaths in London. The health impacts of pollution exposure are wide-ranging, including increased risk of respiratory disease, cardiovascular disease, adverse birth outcomes, and neurological disorders. Children, the elderly, economically disadvantaged groups, and those with existing health conditions are among the most vulnerable.

To combat air pollution, London has implemented one of the world's first Ultra Low Emission Zones (Ulez). Effective in 2019, the Ulez creates a central London area where vehicles must meet strict emissions standards or face daily charges. Early data indicates Ulez has reduced NO₂ and PM_{2.5} within the zone.

Traditionally, ambient air quality monitoring has been conducted by local authorities using expensive reference-grade instruments housed in large roadside cabinets. While critical for regulatory reporting and research, these networks provide limited spatial coverage and little opportunity for community involvement.

With a vision to supplement London's reference monitoring and empower citizens, the Greater London Authority (GLA) partnered with Imperial College London's Environmental Research Group (ERG) to fund the Breathe London network of low-cost sensors in 2021. Leveraging the Clarity Node-S sensors, Breathe London provides Londoners with hyperlocal air pollution data while promoting education, civic engagement, and policy decision-making.

A key enabler of the Breathe London network is the Clarity Node-S. The Node-S measures NO₂ and PM_{2.5}, two priority pollutants for health. Its compact size and solar panel enable installation virtually

anywhere to provide hyperlocal air quality data.

Clarity's sensing-as-a-service model has been invaluable in supporting the large-scale Breathe London network. Clarity hosts a cloud-based data platform to ingest, process, and visualize measurements. Users can access air quality data through a dashboard and API. The dashboard also provides tools to manage devices and configure alerts crucial for managing a network of this scale. If any nodes are damaged or need to be replaced, Clarity swiftly ships free replacement devices to minimize data gaps. ERG has developed proprietary algorithms that correct raw sensor measurements based on data from London's network of reference monitors.

This unique "transfer of value" from the reference network enables Breathe London to provide enhanced data quality and reliability compared to sensor networks in other cities. Today, all Breathe London Node-S devices are colocated with London air reference monitors before calibration is applied and the devices are deployed.

Interfacing with London's existing air quality reference network, Breathe London data is robust enough for research applications and remains accessible to the public. The network has informed analyses of pollution exposure inequalities as well as spatial variability of pollution from traffic, airports, industry, and wood burning. Outcomes help target interventions, including expansion of low-emission zones, deployment of green infrastructure, limiting wood burning, and more.

Unlike many community air quality monitoring initiatives that take a top-down approach, Breathe London is intentional in enabling community-led projects. The team distributes Node-S devices through innovative community programs funded by Bloomberg Philanthropies, through which local groups are encouraged to share their concerns and objectives and apply for a Node-S device. Working together, Breathe London and communities can determine optimal locations

to install Clarity Node-S sensors, which measure PM2.5 and NO2 and run on solar power. Local groups manage the devices day-to-day while Breathe London provides training, data quality assurance, technical support, and a platform to share results.

This grassroots approach ensures each Node-S device is sited based on community priorities. Clarity devices have been installed everywhere, from schools, hospitals, and parks to busy roads, market stalls, and bus stops. As of 2023, the network has grown to over 400 Nodes across all 33 London boroughs.

For many groups, joining Breathe London is their first foray into air quality monitoring. The ability to easily obtain local pollution data is often a catalyst for community organizing and civic participation. Take the case of Clean Air 4 Schools, a group of parents at William Patten Primary School in the London borough of Hackney. After learning the school playground exceeded NO2 limits, the group installed a Breathe London Node-S in 2021. Access to real-time monitoring data enabled compelling outreach campaigns, driving concrete policy changes by Hackney Council, which improved the air quality at William Patten and the surrounding schools.

In addition to community empowerment, Breathe London is generating data to inform urban planning decisions and policies for cleaner air.

With over 400 sensors and counting, Breathe London has become a globally recognized model for community air quality monitoring. Breathe London also provides a model for the Breathe Cities Network, an initiative by the C40 Cities and the mayor of London, Sadiq Khan, to expand community air quality monitoring globally. By combining reference monitoring with affordable, easy-to-use sensors, Breathe London has engaged everyday citizens in improving their local air quality. The initiative provides a model for urban communities worldwide to take air monitoring into their own hands, empowering impact from the ground up.

<https://www.smartcitiesworld.net>

Pigment-Producing Microbes for Dyeing Textiles

A new way to dye fabrics, yarns, and other materials could make the textile industry more sustainable and chemical-free. Fabric dyeing consumes 1.3 trillion gallons of water every year globally, which is the equivalent of two million Olympic-sized swimming pools. Synthetic dyes make up most of the pigments that color garments sold for mass fashion retail, amounting to billions of articles of clothing per year. In addition to using up water resources, these dyes also contain harmful chemicals.

Over the past decade, the UK-based company Colorifix has developed DNA sequencing to derive microorganisms that produce pigments through a fermentation process similar to making beer. The company was a finalist for this year's Earthshot Prize awards that recognize technology innovation. The process involves less water and no chemicals, making for minimal environmental impact. Unlike other sustainable dyes or dyes derived from nature, the Colorifix technology uses the biological process to produce, deposit, and fix pigments to textiles. While natural dyes can be produced without chemicals, the dyes have to be bound to the fabric, which is a process involving chemicals. Colorifix pigments solve both problems—producing pigments and binding them without chemicals.

Instead of the pigment, the message contained within the DNA of a living organism is extracted. This extract is the message [DNA sequence] that specifically relates to how the living organism encodes color.

The customer base of Colorifix is higher up in the fashion chain and consists of manufacturers who produce the raw materials for fashion houses and brands. The distribution model is decentralized, where Colorifix sends vials of the microbes and trains the manufacturers in growing the colors directly on-site. The fermentation hardware is a modular system that can

be scaled up according to the size of the manufacturing facility.

Colorifix currently works with manufacturers in Portugal and Italy but will be expanding to India, Brazil, and other parts of the world in the coming year.

<https://qz.com>

Road suction technology

Roadvent, developed by UK firm Pollution Solution, actively captures vehicle exhaust emissions and ultra-fine particles originating from tires and brake pad wear. Suction technology installed on roads offers a novel solution to the problem of urban air pollution.

Roadvent is discreetly installed into roads to capture, filter, and release clean air on the roadside directly below traffic. This has been independently and scientifically verified to reduce human exposure to road-based air pollution by 91 percent.

A new study led by Swansea University's Professor Paul Lewis appeared to rank Roadvent technology as preferable to several other approaches when it comes to reducing nitrogen dioxide (NO₂) concentrations to below UK regulatory standards.

Roadvent significantly lowers NO₂ concentrations and minimizes the long-term economic burden on healthcare systems without implementing big changes for the public.

<https://envirotechmagazine.com>

Monitoring Indoor Air Quality

Indoor Air Quality (IAQ) is a global concern for health, well-being, and productivity, as people spend 90% of their time indoors. At times, IAQ can be worse than outdoor air quality. Poor air quality in indoor spaces can lead to pathogen transmission, high CO₂ levels that worsen cognitive function, and respiratory issues.

The Building Research Establishment (BRE) recently released a report finding that 2.4 million UK homes are hazardous to health. Employees are demanding more transparency when it comes to IAQ and are aware of the impact of air quality on their health.

According to the Healthy Building Survey 2022 by Honeywell, 62% of global workers would consider leaving their jobs if their employers do not prioritize a healthier indoor environment.

Butterfly is an innovative and patented IAQ monitoring system, including a suite of beautifully designed hardware with integrated software, that has been developed at Imperial College London over the past four years to address this issue responsibly.

Butterfly has received patent status, and it has been meticulously designed, rigorously tested, and backed by scientific research from Imperial College London.

The Butterfly system offers dual functionality: monitoring and management. Particulate Matter (PM) is one of the biggest areas of focus for the next generation of building management. The Butterfly can control the way a building "breathes," offering both Indoor and Outdoor Air Quality measurement on a location-specific basis to provide 20/20 vision – an industry first – with sensors measuring different levels of PM, including PM₁, PM_{2.5}, and PM₁₀. Butterfly can, therefore, help reduce PM for current occupants, plus minimize energy consumption with impactful benefits on sustainability, thus contributing to lower emissions and a fully circular outcome. The system has already been deployed at Imperial College, covering a range of modern and historic buildings and showcasing its adaptability across diverse property portfolios. It not only keeps a vigilant eye on air quality but also optimizes building operations, potentially saving up to 40% of energy consumption.

The Butterfly IAQ monitoring system leverages cutting-edge technology to provide highly accurate and user-friendly data, explains the group. A unique sensing chamber, LaminAIR flow, is said to provide accurate measurements by controlling the sample airflow while its intuitive gloWING Interface changes color to reflect air quality, making it easily accessible for users.

Butterfly offers a flexible suite of products to meet international standards for various building types, from battery-powered Sapho and Antenna to cable-powered Morpho. The system hub, Chrysalis, connects all monitors and exports data to the Butterfly portal via multiple secure channels.

Butterfly seamlessly integrates with Building Management Systems (BMS) to optimize IAQ and minimize energy use, offering a substantial return on investment through enhanced well-being and sustainability.

Butterfly's secure platform continuously ingests data from all devices, empowering clients to monitor and manage their indoor spaces effectively, while the Butterfly App provides mobile connectivity across all devices, offering efficient and user-friendly data access.

<https://envirotechmagazine.com>

CHINA

Reusable Batteries

Green, Renewable, Sustainable Technology (GRST), an eco-friendly lithium-battery technology start-up based in Hong Kong, has been named one of five winners of this year's Earthshot Prize.

The inventor of a water-based battery manufacturing and recycling technology will receive a £1 million (US\$1.2 million) cash prize to help scale up its operations to bring positive impact to the planet's climate, environment, and people. It was among the 15 finalists nominated in September.

GRST is the first company from Hong Kong or mainland China to win the prestigious award.

"With the development of a new way to build and recycle vital lithium-ion batteries, GRST's solution offers a pathway to make the electric cars of the future even cleaner," said an Earthshot Prize statement issued during the awards ceremony held in Singapore late on Tuesday. GRST was the winner in the "Clean Our Air" category.

Britain's Prince William launched the Earthshot Prize in 2020 to search for and scale up the most innovative solutions to the world's greatest environmental challenges by 2030.

"The last year has been one of great changes and even greater challenge," Prince William said in the statement. "A year in which the effects of the climate crisis have become too visible to be ignored," he continued.

The five winners were selected by Prince William and the Earthshot Prize Council, chaired by Christiana Figueres, architect of the Paris Agreement signed by over 190 nations that have made commitments to decarbonize their economies and fight climate change.

The other winners include the South American forest protection community-based initiative Accion Andina, ocean conservation group WildAid Marine Program, India-based solar-powered crop-drying equipment developer S4S Technologies, and land restoration carbon-credit marketplace operator Boomitra.

GRST, founded in 2015 and based in the Hong Kong Science and Technology Park, said that its technology can cut emissions of greenhouse gases by up to 40 percent during the production of lithium-ion batteries and by up to 80 percent during recycling.

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The world will need many batteries to achieve net zero [emission] by 2050, but a revolution is needed to make these batteries cleaner and more recyclable. Today, our water-based technology is driving this transformation to provide consumers with a sustainable energy future.

The start-up aims to raise US\$50 million over the next two years to fund joint ventures in Europe and North America as it vies to grab a slice of the fast-growing sustainable batteries market. This includes raising about US\$25 million through its series B fundraising round in the next few months to add some strategic collaborators to its shareholder base.

The entire lithium-ion battery supply chain, from mining to battery recycling, can grow by over 30 percent annually between last year and 2030. By that time,

it can potentially reach a scale of 4.7 trillion kilowatt-hours valued at over US\$400 billion, according to the forecast by the business consultancy McKinsey.

Conventional batteries are energy-intensive because they need to be produced at high temperatures and low humidity and require binding chemicals made from fossil fuels. GRST's technology removes such requirements. Recycling of conventional batteries is also highly energy-intensive and results in the emission of toxic fumes.

<https://www.scmp.com>

Rocket with Remote Sensing Satellites Launched

China launched a Long March 6A carrier rocket on Sunday to send a remote-sensing satellite into orbit. The rocket blasted off at 12:30 pm from the Taiyuan Satellite Launch Center in Shanxi province and successfully placed the Yaogan 40 satellite into its intended orbit.

Remote-sensing satellites are used to observe, survey, and measure objects on land or at sea, as well as monitor weather. The Yaogan family is the largest fleet of remote-sensing spacecraft in China, and governments, public service sectors, and businesses have widely used their data.

The Yaogan 40 satellite is designed to obtain data on the electromagnetic environment and conduct related technological tests.

The medium-lift rocket is a product of the Shanghai Academy of Spaceflight Technology and consists of a 50-meter liquid-propelled core booster and four solid-fuel side boosters. It has a liftoff weight of 530 metric tons and is mainly tasked with transporting satellites to multiple types of orbits, including sun-synchronous, low-Earth, and intermediate circular.

The mission was China's 42nd rocket launch this year and the 487th flight of the Long March rocket family, the nation's main launch vehicle fleet.

<https://www.chinadaily.com>

ISRAEL

Air Conditioning Through Humidity in Air

Israeli startup ThermoTerra is developing a renewable energy system that harvests energy from fluctuations in humidity.

Water vapor in the air absorbed by a material transfers a significant amount of energy. Evaporation of water causes a cooling effect. Think about the human body – when we are hot, we produce sweat that, when it evaporates, keeps us from overheating.

When water vapor is absorbed or condenses on a material, the opposite occurs: it generates heat.

On a hot day, ThermoTerra's technology brings ambient warm and dry air into the home or office. It is stored inside the insulation of the building's walls — hempcrete, silica gel, or wood wool insulation can absorb humidity especially well. When the air evaporates subsequently, it absorbs energy and cools the building.

When temperatures are cooler, cold and humid air is brought in; as this air is absorbed, it warms the air, heating the home or office.

The ThermoTerra system is controlled by sensors embedded in the walls. Smart algorithms monitor when to bring in hot or cold air and when to release it. The algorithms learn owner preferences and automatically adjust the temperature accordingly. They can also tap into external weather forecasts.

If it is very hot now but the system knows that in a week it will be cold, it can store water in advance. The need for new technologies like ThermoTerra is indisputable: Some 40 percent of the energy usage in buildings around the world is spent on heating and cooling, and buildings represent 30% of the world's energy usage.

ThermoTerra's system is composed of three main components:

To work its magic, ThermoTerra requires integrating a structure of ducts and conduits into a new wall. In existing

buildings, a new façade with built-in insulation and ducts can be added to the walls. This may take up a few inches, but the environmental impact and financial savings are significant, claims the company.

This is a system of fans, ducts, and dampers. A smart fan is inserted into the wall, controlled by algorithms, and moves the hot or cold air around as required. This is the only part of the system that requires electricity.

ActiveMemBrain consists of IoT smart sensors, the controller, algorithms, and cloud computing. Storage reservoir contains a special absorption material packed inside a wall with air channels designed for maximum air flow.

Using special materials that can absorb a large amount of water, combined with the company's patent-pending control system, ThermoTerra uses humidity variations to charge the insulation material – making it drier in winter or damper in summer – and then force the air through the material to release hot or cold air as necessary.

By constantly passing such ambient air through its system, ThermoTerra smooths out the peaks and troughs so that both temperature and humidity cycles are shallower, resulting in a more comfortable environment.

Traditional mud and clay buildings are very good at keeping the cold out and the heat in using humidity. By tapping into the natural fluctuations in humidity, one could increase the temperature from 12 degrees Celsius (53.6 Fahrenheit) to 26 degrees Celsius (78.8 Fahrenheit).

Zchori founded ThermoTerra in 2015 with patent attorney Jeremy Rutman and data analysis expert Yonatan Nathan. The company employs five people. The Israeli Ministry of Energy, the Israel Innovation Authority, and the founders have provided the funding. The company is currently applying for an EU research grant.

The company is seeking such collaboration now as it is in the product development phase, conducting experiments in different parts of Israel.

Going forward, ThermoTerra may be used to cool cars. When a car is sitting in the sun, it gets hot. We can cool it using evaporative water harvested overnight.

<https://www.israel21c.org>

REPUBLIC OF KOREA

Organic–Inorganic Hybrid Gas Sensors

The world has become increasingly industrialized over the past few centuries, bringing technology and convenience to the masses. However, workers in industrial environments are often at risk of exposure to many dangerous gases, such as nitrogen dioxide (NO₂). Inhaling this gas can lead to serious respiratory diseases, like asthma and bronchitis, and severely compromise the health of industrial workers. Constant monitoring of NO₂ levels is thus needed to ensure a safe workplace.

To help with this, many types of selective gas sensors have been developed using different organic and inorganic materials. Some of them, such as gas chromatography sensors or electrochemical gas sensors, are highly sophisticated yet expensive and bulky. On the other hand, resistive and capacitive sensors based on semiconductors seem to be a promising alternative, with organic semiconductor (OSC) gas sensors representing a low-cost and flexible option. Nonetheless, these gas sensors still face some performance issues, including low sensitivity and poor stability for sensor applications.

Against this backdrop, a team of researchers from Korea, led by Professor Yeong Don Park from the Department of Energy and Chemical Engineering at Incheon National University, set out to find innovative strategies to take Organic Semiconductor (OSC) NO₂ sensor technology to the next level. Their study was made available online on August 15, 2023, and published in Volume 473 of the Chemical Engineering Journal on October 1, 2023. It was carried out in collaboration with researchers from Jeonbuk National University, including Professor Min Kim.

To this end, the team proposed a hybrid organic–inorganic gas sensor design based on the combination of a conductive organic polymer and perovskite nanocrystals. They incorporated a CsPbBr₃ perovskite into a conductive polymer matrix to enhance its gas sensing performance while maintaining sensing speed. They further modified the surface of the perovskite nanocrystals with zwitterionic polymer ligands. Once hydrated, these ligands greatly improved the affinity of the sensor for NO₂ gas molecules, thus resulting in improved absorption.

Further experiments revealed that the proposed design outperformed conventional sensors in terms of chemical sensitivity to NO₂. Moreover, their system was highly resistant to oxidation, thanks to the protective action of the perovskite nanocrystals. Thus, it could withstand storage in ambient conditions for several weeks, showcasing impressive durability and higher potential for long-term installation.

Given that OSCs can be designed to be flexible, lightweight, and relatively inexpensive when mass-produced, they could pave the way to the widespread adoption of gas sensors in various contexts. Beyond specific settings like industrial sites, OSC gas sensors could enable individuals to readily access information about air pollution levels through commonplace devices like smartwatches. Moreover, these sensors have the potential to advance diagnostic technology by facilitating the early detection of medical conditions. Therefore, it has potential not only for industrial safety but also in the realms of food safety, chemical substance monitoring, and medical diagnosis.

<https://www.eurekaalert.org>

All-in-One Air Purifier-Sterilizer

The Korean Federation of Mechanical Engineering Societies named the “discharge technology/air sterilizing purifier for removing bacteria and viruses floating in the air,” jointly developed by Kumoh Industry with the Korea Institute

of Industrial Technology, one of the “Top 10 Mechanical Technologies of the Year 2020.”

The KIAS All-in-One is an innovative premium air sterilizer that combines clean technology with sterilization technology. This hybrid air purifier, which combines air sterilization and air purification functions at the same time, is capable of comprehensive and effective indoor air quality management. Furthermore, it is equipped with DBD plasma, which uses innovative patented sterilization technology. Plasma removes fine dust, bacteria, and viruses smaller than 0.3 μm and generates hydroxy radicals, a powerful sterilizing and disinfecting substance, while eliminating 99.9% of airborne bacteria, such as super bacteria and E. coli.

Among the air purifier products available in the global market, there are only two complex air sterilizing purifiers that remove bacteria and viruses, including Kumoh Industry’s KIAS. Despite being a latecomer to the market, Kumoh Industry has a “comparative advantage” over other complex air sterilizing purifiers in terms of price, power consumption efficiency, and maintenance.

Kumoh Industry’s KIAS generates plasma at low voltage to capture bacteria, viruses, and volatile organic compounds (VOC). KIAS’ technology, based on the creation of “dielectric barrier discharge plasma,” was developed after two years of research conducted jointly by Kumoh Industry and the Korea Institute of Industrial Technology.

KIAS’ plasma generation technology can operate at low voltage (60 W/h, maximum), making it competitive with other products that employ high-voltage plasma generation technology. It is also more affordable at about a third of the price of its competitors.

<https://www.businesswire.com>

Gas Sensor Technology Proposed for Industrial, Medical Settings

Researchers at South Korea’s Incheon National University and Jeonbuk National

University are proposing an innovative approach for creating organic-inorganic hybrid gas sensors, which have shown to be durable, selective, and highly sensitive.

In a paper published in the Chemical Engineering Journal, the scientists point out that harmful gases, such as nitrogen dioxide, are commonplace in industrial settings.

NO₂ inhalation can lead to serious respiratory diseases like asthma and bronchitis and severely compromise the health of industrial workers. Constant monitoring is thus needed to ensure a safe workplace.

To help with this, many types of selective gas sensors have been developed using different organic and inorganic materials. Some of them, such as gas chromatography sensors or electrochemical gas sensors, are highly sophisticated yet expensive and bulky. On the other hand, resistive and capacitive sensors based on semiconductors seem to be a promising alternative, with organic semiconductor (OSC) gas sensors representing a low-cost and flexible option. Nonetheless, these gas sensors still face some performance issues, including low sensitivity and poor stability for sensor applications.

Against this backdrop, the Incheon team led by Yeong Don Park set out to find innovative strategies to take OSC NO₂ sensor technology to the next level. To this end, the team proposed a hybrid organic-inorganic gas sensor design based on the combination of a conductive organic polymer and perovskite nanocrystals. They incorporated a CsPbBr₃ perovskite into a conductive polymer matrix to enhance its gas sensing performance while maintaining sensing speed. They further modified the surface of the perovskite nanocrystals with zwitterionic polymer ligands. Once hydrated, these ligands greatly improved the affinity of the sensor for NO₂ gas molecules, thus resulting in improved absorption.

Further experiments revealed that the proposed design outperformed conventional sensors in terms of chemical

sensitivity to NO₂. Moreover, their system was highly resistant to oxidation, thanks to the protective action of the perovskite nanocrystals. Thus, it could withstand storage in ambient conditions for several weeks, showcasing impressive durability and higher potential for long-term installation.

The new approach for the development and design of gas sensors is based on various material composites to achieve both superior sensitivity and selectivity. Given that OSCs can be designed to be flexible, lightweight, and relatively inexpensive when mass-produced, they can pave the way for the widespread adoption of gas sensors in various contexts.

Beyond specific settings like industrial sites, OSC gas sensors can enable individuals to readily access information about air pollution levels through commonplace devices like smartwatches. These sensors have the potential to advance diagnostic technology by facilitating early detection of medical conditions. Therefore, it has potential not only for industrial safety but also in the realms of food safety, chemical substance monitoring, and medical diagnosis.

<https://www.mining.com>

Light-Activated concrete to scrub Air Pollution out of traffic tunnels

Traffic is among the biggest sources of air pollution, but what if the roads themselves can help clear the air? Engineers in Korea have now demonstrated that photocatalytic concrete can help reduce pollution in tunnels.

While we need to transition to greener vehicles as soon as possible, it is still going to take a few decades. In the meantime, finding other ways to mitigate air pollution is important. So, why not turn to the most common building material in the world to help? In recent years, scientists have developed concrete that can convert some of the pollutants in the surrounding air into harmless products.

These air-purifying concrete systems rely on a coating of titanium dioxide, which reacts with sunlight to produce molecules called reactive oxygen species (ROS). These have strong oxidizing power, which breaks down air pollutants like volatile organic compounds (VOCs), nitrogen oxides, sulfur oxides, and ammonia to prevent the formation of fine particulate matter.

In the new study, researchers at the Korea Institute of Civil Engineering and Building Technology (KICT) developed this kind of photocatalytic concrete and tested it in a traffic tunnel, where pollution is often higher due to poor air circulation. Artificial lights were installed along the walls to fuel the light-activated reactions in the concrete.

The team found that the levels of nitrogen oxides dropped by about 18% over 24 hours, and the end products of the reactions were salts formed in part from the calcium in the concrete. These salts were quickly washed away by rain. Better yet, the team says this process should allow the photocatalytic concrete to function indefinitely without needing any extra maintenance beyond that of regular concrete.

The team plans to continue researching the technology to help get it commercialized and improve its effectiveness. Other examples have managed to reduce nitrogen oxide levels by 45%, or even an astonishing 70%, when paired with graphene.

Construction technology using photocatalysts can have an immediate effect on reducing fine particulate matter in the nation's living environment. There are plans to build a system of cooperation with local governments and public corporations to expand trial demonstrations to other sites and achieve commercialization and distribution with practical effects.

An earlier paper describing the photocatalytic concrete was published in the KSCE Journal of Civil and Environmental Engineering Research.

<https://newatlas.com>

Customized Air Purification of Toxic Gases

There are Volatile organic compounds (VOCs) in daily products such as paints, adhesives, furniture, cosmetics, and deodorants. Constant exposure to these can cause serious health problems such as respiratory illness, headaches, dermatitis, and cancer. Natural ventilation is the most effective way to reduce VOCs in indoor air. However, recently, air purifiers have become a common method to maintain indoor air quality due to the frequently extreme outdoor conditions (e.g., high concentrations of fine dust, heat waves, and extreme cold). Generally, air purifiers remove VOCs by adsorption using activated carbon, which has a non-polar carbon surface and a large specific surface area. This activated carbon can effectively remove non-polar substances such as toluene and benzene but cannot remove polar substances such as ketones and aldehydes.

The Korea Institute of Science and Technology (KIST) announced that Dr. Jiwon Lee and Dr. Youngtak from the Center for Sustainable Environment Research have developed a new adsorbent technology that can efficiently adsorb amphiphilic VOCs, which have both hydrophilic and hydrophobic properties and are difficult to remove with existing activated carbon technology.

The KIST research team synthesized a graphene-iron oxide heterostructure by precisely controlling the surface oxidation of graphite and iron, resulting in a high adsorption capacity for amphiphilic VOCs due to the increase of oxygen functional groups and iron oxide on the surface. This unique adsorbent showed up to 15 times better adsorption efficiency for amphiphilic VOCs than conventional activated carbon adsorbents do.

They also found that precise control of oxygen functional groups and iron oxides in the adsorbent can offer flexible surface optimization freedom for the desirable nature of the pollutant.

By testing four different ketones that are difficult to control with activated carbon adsorbents, the researchers found the correlation between the length of carbon chains and the adsorption efficiency; by optimizing the content of oxygen functional groups and iron oxides in the adsorbent, they were able to bring the maximum removal efficiency for the ketones. The researchers also analyzed the sub-nanometer electron transfer phenomenon between the adsorbent and VOC molecules; they found a link between the geometric shape of the

pollutant and its adsorption trend for the first time. This is expected to enable the development of customized detection and control technologies for various air pollutants in our environment.

Unlike previous studies that focused on mere improvement of the adsorption performance and regeneration efficiency of adsorbents, this study helped the team succeed in developing a breakthrough material that exceeds the limits of existing adsorbents using accessible materials such as graphite and iron, which have high commercialization potential.

KIST was established in 1966 as the first government-funded research institute in Korea. KIST now strives to solve national and social challenges and secure growth engines through leading and innovative research.

The research, which was conducted as a major project of KIST (Air Environment Research Program) with support from the Ministry of Science and ICT (Minister Jong-ho Lee), was published in the Chemical Engineering Journal.

<https://www.newswise.com>