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KNOWLEDGE ABOVE ALL

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ENERGY

BY SHREEYESH S.

THE CRYOGENIC HYDROGEN POWERTRAIN THAT WILL TRANSFORM PROPULSION

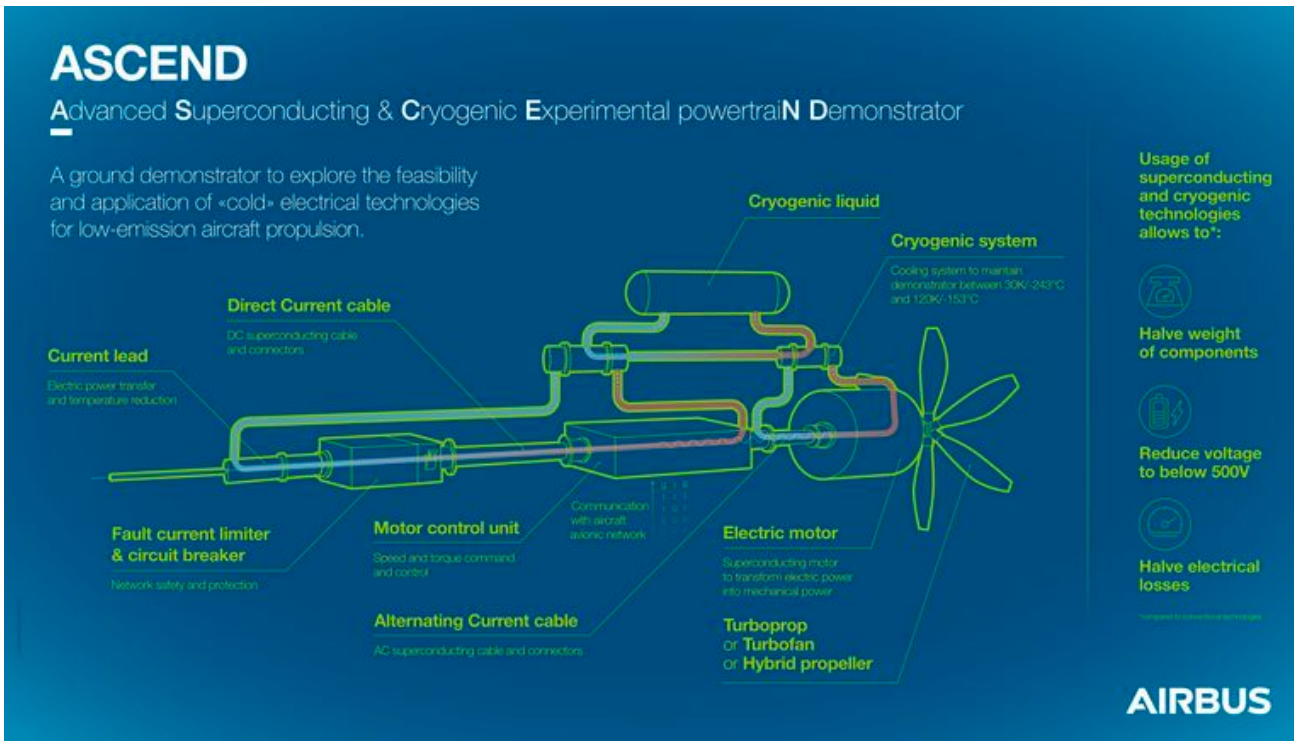
In the ongoing fight against carbon emissions, air travel has a particularly bad position because of the industry's reliance on high speeds, light weights, and fossil fuels. But Airbus's new superconducting powertrain, which is cooled by super cold liquid hydrogen, may solve some of those pressing problems.

The new system—named Advanced Superconducting & Cryogenic Experimental powertrain Demonstrator (ASCEND)—is in ground-based demonstrations. The three-year project "aims to show that an electric- or hybrid-electric propulsion system can be more than 2 to 3 times lighter than a conventional system without compromising a 97 [percent] powertrain efficiency," Airbus says.

If it works, ASCEND could be a landmark achievement in future-looking aeronautics. The snag facing electric aircraft designs mostly comes down to a matter of weight. On the ground, cars can add up to 1,000 pounds worth of batteries. But in the sky, that could mean the difference between an aircraft flying or sinking. Passenger planes in particular are already a very finely balanced system.

For now, the system is only on the ground as engineers work on it for demonstrations. If ASCEND makes it to primetime, it will approach parity with traditional fossil fuel aircraft, Airbus says. Airliners are a special case, but Vancouver-based Harbour Air is working on electrifying its fleet of small local planes. It's possible to do—it's just difficult or impossible to scale up to jumbo jets.

Certainly no "regular" electric plane can compete with something that runs on superconducting electrics, so if Airbus brings ASCEND into its fleets in future decades, the manufacturer will essentially have the sky to itself.



CHEMISTS JUST FIGURED OUT A WAY TO TURN CO2 INTO JET FUEL

MANDAR KOLI-
STUDENT

Between the COVID-19-related decline in air travel and increased scrutiny on airplane fuel consumption, it's been a rough time for airlines. But in new research, scientists from the University of Oxford offer a novel way to turn waste CO2 into usable hydrocarbons—and even into jet fuel.

The secret is a complex chemical catalyst, made by blowing up elements and using materials like citric acid or even regular household flour as catalyst fuels.
Jet engines are, surprisingly, pretty robust. They can accept a wide variety of fuels, including a new partial biomass regiment just introduced by England's Royal Air Force. The marketplace of ideas is wide open to people with new concepts for making the airplanes run, with implications for entire fields like defense and research.

That's also because even during the worst passenger flight year on record, cargo still flies, including international mail, fresh food, and consumer goods. (Most manufactured goods and even a lot of fresh food are still shipped on, you know, ships. The cost saving to companies with well-established oversea logistics is enormous, and cargo ships are surprisingly environmentally efficient compared with other options.)

AMERICAN HONEY STILL CONTAINS NUCLEAR FALLOUT FROM THE 1950S

ANIKET DESHMUKH-
FACULTY

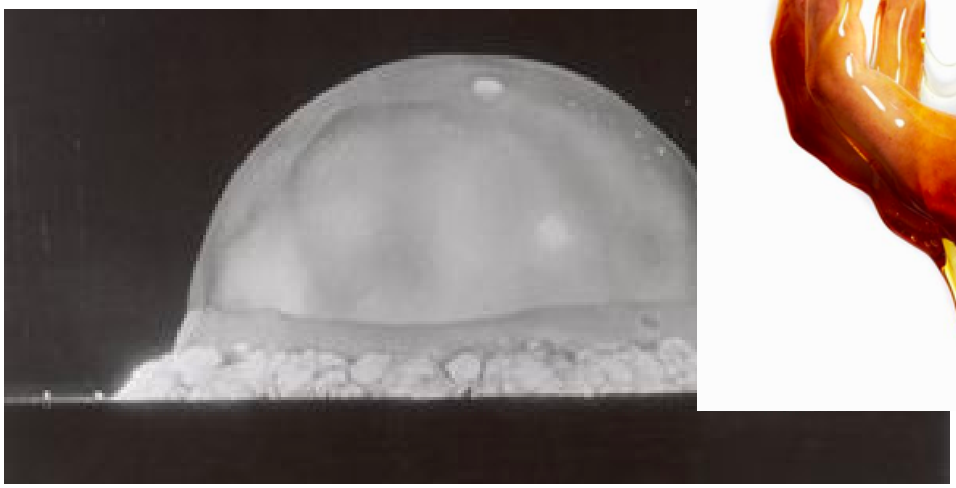
Drizzle some radioactivity in your tea: Scientists say nuclear fallout from Cold War weapons testing is still showing up in U.S. honey today, and the secret to the lingering traces is a sneaky chemistry twist.

It's important to note the levels are not high enough to be harmful, say the scientists, from the College of William & Mary. But how is radioactivity still lingering in honey production after 60+ years?

The key ingredient is called radiocesium. Radioactive cesium is a fission product thrown off by hundreds of nuclear weapon test blasts from global superpowers, including the U.S., during the '50s and '60s. The isotope's radioactive half life is 30 years, meaning the worst of the radiation from these specific test blasts is well behind us.

But the decades-old radiocesium is still in circulation for bees because it's close enough to the element potassium, one of the essential nutrients for plants, humans, and other animals. Plants mistakenly absorb radiocesium, believing it to be potassium. Honey not only picks up local plants' chemical composition, but magnifies it because of the mechanism of how honey is made, say the scientists. Bees consume nectar and, like the people who turn maple sap into syrup, concentrate the nectar so it's up to five times thicker. What's left has even more of the local chemical composition.

While the minuscule radiation levels in honey are completely safe for humans today, that doesn't mean there isn't, well, fallout for other species. Scientists should now look into how radiocesium has impacted bees since the weapons testing; bumblebees near Chernobyl were less able to reproduce after the 1986 disaster, for example.



APPLE JUST MADE A HUGE INVESTMENT IN AN ANCIENT TECHNOLOGY: TREES

RAJ DEVKAR-
FACULTY

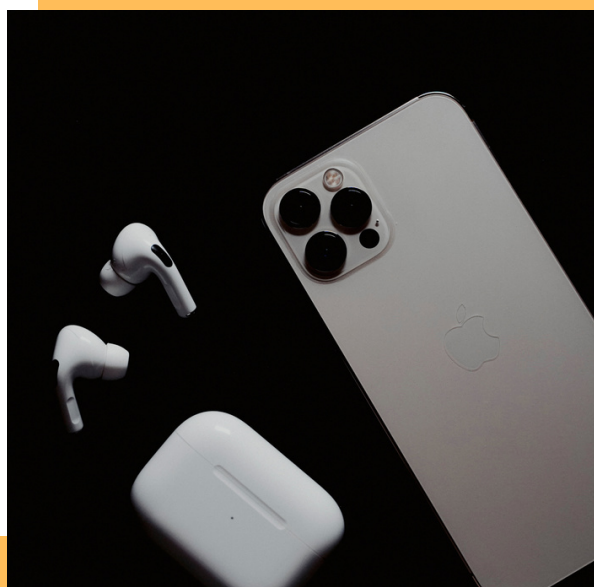
Apple has announced sweeping new plans for the Restore Fund, a project that will accelerate carbon removal and plant millions of new trees around the world.

The tech titan says its initiative, launched in collaboration with Conservation International and Goldman Sachs, is the first of its kind. The $200 million fund will remove at least 1 million metric tons of carbon dioxide from the atmosphere—that's the equivalent of 200,000 passenger vehicles—every year.

Researchers estimate that tropical forests on the planet today still hold more carbon than humanity as emitted over the past 30 years by burning coal, oil, and natural gas. "That's even with the ongoing amount of deforestation that is out there," says Jackson.

Apple's prior work with Conservation International includes restoring carbon-thirsty mangrove swamps in Colombia—mangroves are somewhere between bamboo plants and skinny trees, growing wild all over the tropical regions on Earth—as well as savanna in Kenya.

"In both [Colombia and Kenya], we loved the way they bring communities into the project," Jackson says. "It's additive to community wealth, not extractive of community wealth. We see a role for business to show you can have an additive impact on communities, rather than extracting the value for community and leaving less there than what was there before you started."



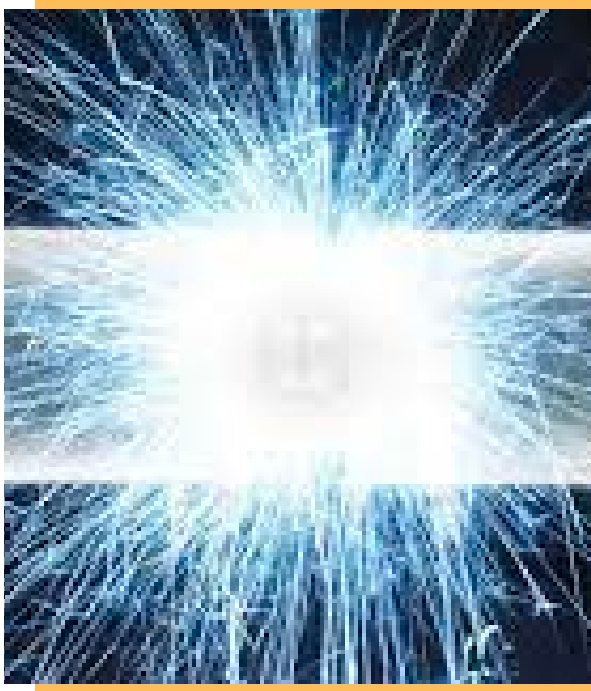
"Trees are nature's technology to handle carbon removal," says Jackson, who was the Administrator of the U.S. Environmental Protection Agency from 2009 to 2013. "We want to show how to do it the right way, and we want it to be profitable."

THE RADIOACTIVE BATTERY THAT WILL RUN FOR 28,000 YEARS

SUSHIL MISHRA-
FACULTY

In less than two years, you might be able to buy a smartwatch—powered with a radioactive diamond battery—that will outlive you and your progeny for generations. The potentially game-changing battery comes from the San Francisco-based startup Nano Diamond Battery (NDB), which lauds its namesake "high-power diamond-based alpha, beta, and neutron voltaic battery" for its ability to give devices "life-long and green energy." Imagine: Just one battery could power your insulin pump or pacemaker for your entire life (with loads of time to spare). Or it could provide the juice for a space rover, collecting Mars regolith samples for decades without any human assistance.

Those are ambitious goals. So, could NDB's bold claims actually become reality?



First, let's dissect the specs. To build its Nano Diamond Battery, NDB uses layers of impossibly tiny, paneled nano diamonds (for context, one nanometer is one billionth of a meter). Diamonds have exceptional heat conductance, which makes them ideal for electronic devices. In fact, they are the best-known natural conductor of heat, according to a publication by the University of Houston's College of Engineering—and are three to four times more effective than copper or silver.

Scientists cultivate these miniature diamonds using chemical vapor deposition, a process in which gases at extremely high temperatures force carbon to crystallize on a substrate material. That process, NDB admits, creates a cost bottleneck; making the special diamonds is energy-intensive and expensive.

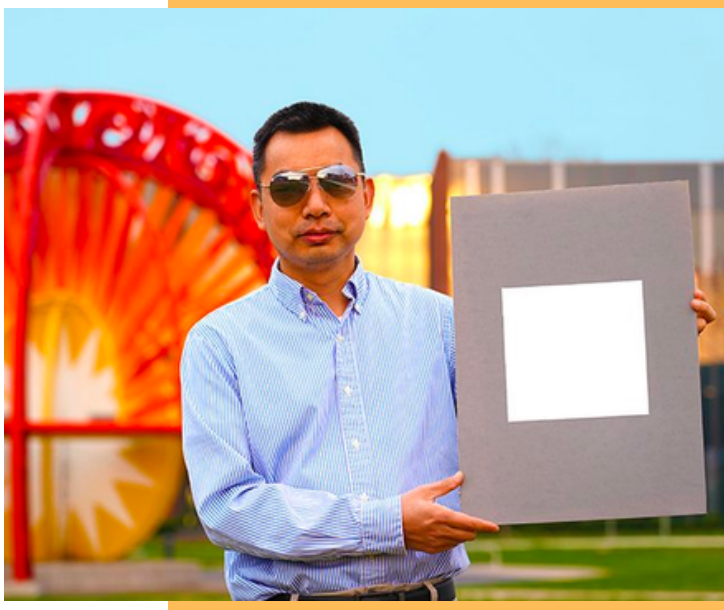
After all, they're "artificially boron-doped diamonds," explains Yury Gogotsi, director of the A.J. Drexel Nanomaterials Institute at Drexel University in Philadelphia. (Gogotsi has no affiliation with NDB.) That process produces diamonds with blue color and higher conductivity than the average diamond. True blue diamonds are naturally occurring on Earth, but they're rarer and even more expensive than artificial blue diamonds.

THE WHITEST PAINT EVER COULD BLOCK THE SUN AND COOL EARTH

MANOJ YADAV - FACULTY

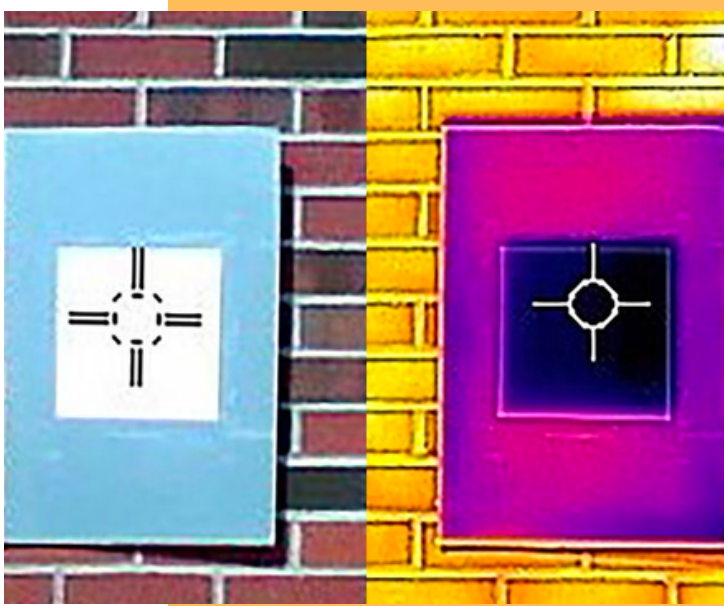
Purdue University engineers made the paint, which consists primarily of barium sulfate, a compound used in cosmetics and ultrawhite paper products. Barium sulfate is extremely reflective, and that's the key to making anything white: it must bounce away as much light as possible, rather than absorbing it, like the ultrablack Vantablack paint product.

The twist with this ultrawhite paint is the barium sulfate is also included in different particle sizes, which means more unpredictable surface area coverage that bounces even *more* light away.



The sky is the limit on pure white pigments in theory, but if the product is paint, it still has to hold together as, well, an effective paint product. That means the new paint reflects 98.1 percent of sunlight, which is a vast improvement over the team's last iteration at 95.5 percent. Anything further, the scientists say, and the paint just wouldn't work as paint anymore.

But more importantly, the right paint on a well-designed building could eliminate the need for air conditioning in some locations. "Radiative cooling is a passive cooling technology that offers great promises to reduce space cooling cost, combat the urban island effect, and alleviate global warming," the researchers write in their new study, which appears in *ACS Applied Materials & Interfaces*. They say their single-layer paint is the most effective product of its kind to date, replacing both costly (and less effective) heat-reducing paints, as well as more novel solutions like reflective metal plating. The ultrawhite paint works better and is likely easier to use, going on like regular paint—because it *is* just paint.



ELON MUSK WILL PAY YOU $100 MILLION TO FIGURE CARBON REMOVAL

VIDHI JANI
STUDENT

When last we checked in on Elon Musk, he and his team at Neuralink were wiring up a monkey to play video games with its mind. But a new week brings a new ambitious mission for Musk, and so today, he's offering $100 million to whoever can come up with the best carbon removal technology.

Musk's money is the grand reward for the international XPRIZE Carbon Removal competition, which will properly kick off in 2022 and run for four years. From XPRIZE:

The world's leading scientists estimate that we may need to remove as much as 6 gigatons of CO2 per year by 2030, and 10 gigatons per year by 2050 to avoid the worst effects of climate change. For humanity to reach the Paris Agreements goal of limiting the Earth's temperature rise to no more than 1.5˚(C) of pre-industrial levels, or even 2˚(C), we need bold, radical tech innovation and scale up that goes beyond limiting CO2 emissions, but actually removes CO2 already in the air and oceans. If humanity continues on a business-as-usual path, the global average temperature could increase 6˚(C) by the year 2100.

The XPRIZE contest is asking anyone from around the world to "demonstrate solutions that can pull carbon dioxide directly from the atmosphere or oceans ultimately scaling massively to gigaton levels, locking away CO2 permanently in an environmentally benign way," according to the organization.
Solutions will be scientifically evaluated across multiple criteria such as; amount of CO2 removed, life cycle analysis of the removal process, energy efficiency, land footprint and sequestration capabilities.

Any carbon negative solution is eligible: nature-based, direct air capture, oceans, mineralization, or anything else that sequesters CO2 permanently.