Show Notes 5 September 2025

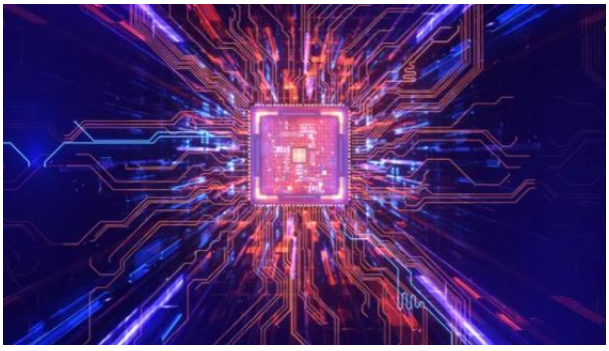
Story 1: Scientists use quantum machine learning to create semiconductors for the first time – *and it could transform how chips are made*

Source: LiveScience.com Story by Becca Caddy

Link: https://www.livescience.com/technology/computing/scientists-use-quantum-machine-learning-to-create-semiconductors-for-the-first-time-and-it-could-transform-how-chips-are-made

Note – the date of the article was July 29, so the "first" claim may, or may not, still be accurate. Regardless, it is an interesting development.

See research paper here:
https://advanced.onlinelibrary.wiley.com/doi/10.1002/advs.202506213



- Australian researchers from the national science agency of Australia, and University of Melbourne, have developed a pioneering method using quantum machine learning (QML) to model *electrical resistance* within microchips.

- **Side note - What is Quantum Machine Learning?**

  - **Definition:** Quantum Machine Learning refers to quantum algorithms designed to solve machine learning problems. These algorithms use quantum bits (qubits) and quantum operations to process data in ways that classical computers can't easily replicate.

  - **Goal:** To improve the speed, efficiency, and scalability of machine learning tasks by leveraging quantum mechanics.

  - **Key Concepts – optional homework** 😊

    Qubits: Unlike classical bits (0 or 1), qubits can exist in a superposition of states, enabling parallel computation.

    Superposition & Entanglement: These quantum properties allow for more complex data representations and faster processing.

    Quantum Speedup: Certain QML algorithms may offer exponential speedups over classical counterparts for specific problems.

    A quantum processor uncovers patterns, and then a classical system interprets the results.

- From the introduction of the research paper the team set the stage for the motivation behind their work: "*The rapid advancement of semiconductor technology has led to increasingly complex fabrication processes, where device performance is highly sensitive to numerous process parameters. However, collecting large, high-quality experimental datasets to model, understand, and optimize such processes remains challenging due to the cost and time constraints associated with semiconductor manufacturing*".

- *[At the time of the announcement]* This is the first time quantum machine learning has been applied to semiconductor design, potentially transforming chip manufacturing.

- Chip Performance Enhancement
  - Modeling electrical resistance is crucial in chip design — it impacts speed, efficiency, and reliability.

    - Quantum machine learning offers a way to improve precision and simplify complex calculations, which could make chip design faster and more scalable.

- The team's study marks a significant leap in combining AI and quantum tech for practical applications in electronics.

Story 2: How used EV batteries could help fuel the AI boom

Source: CBS News

Link: https://www.cbsnews.com/news/used-ev-batteries-artificial-intelligence/

See also: https://www.crusoe.ai/

See also: https://www.redwoodmaterials.com/

- In a field outside Reno, Nevada, an outfit called Crusoe Energy Systems [a developer of an AI cloud-computing platform] has paired rows of solar panels with stacks of used electric-vehicle batteries—sourced from recycling firm Redwood Materials—to keep its data centers powered continuously, day and night.
    - **How the used EV car batteries are processed**:

- Crusoe Energy Systems is refurbishing and repurposing used EV car batteries through a strategic partnership with Redwood Materials, a leader in battery recycling and second-life applications.

- **Refurbishment and Repurposing Process**

    - **Step 1:** Battery Sourcing - Redwood processes over 20 GWh of lithium-ion batteries annually.

    - **Step 2: Second-Life Evaluation -** Many EV battery packs still retain most of their original capacity even after vehicle retirement. These are assessed for functionality and safety before reuse.

    - **Step 3: Stationary Storage Conversion -** Instead of immediate recycling, Redwood repurposes these functional packs into stationary energy storage systems. This extends their useful life and reduces waste.

    - **Step 4:** These refurbished batteries are deployed in Crusoe's modular AI data centers, known as **Crusoe Spark**, which include power, cooling, and GPU-ready racks in a compact, portable format.

- **Microgrid Deployment**: The result is a massive 12 MW and 63 MWh microgrid — *the largest second-life battery deployment in the world* — powering Crusoe's AI infrastructure off-grid with renewable energy.

    - Remember, for example, 12 megawatts, is a unit of power equal to 12 million watts

- **Benefits of This Approach**

    - **Speed**: Enables rapid deployment of AI data centers without waiting for traditional grid expansion.

    - **Sustainability**: Extends battery life and reduces environmental impact.

        - **Cost Efficiency**: Offers a lower-cost alternative to new battery systems while maintaining high performance.

    - This model exemplifies *a circular energy economy*—repurposing before recycling—to meet the growing demands of AI and clean energy infrastructure.

- Redwood Materials recently struck a partnership with General Motors to secure end-of-life battery packs.

- According to Colin Campbell, Redwood's chief technology officer, these second-life batteries typically retain about 80 percent of their capacity—insufficient for vehicle use but ideal for grid-scale storage.

Story 3: Carbon-Negative Building Material Made from Seawater and CO2

Source: TechnologyNetworks.com Story by Alexander Beadle

Link: https://www.technologynetworks.com/applied-sciences/news/carbon-negative-building-material-made-from-seawater-and-co2-397532

Credit: Northwestern University.

- Researchers at Northwestern University in Evanston, Illinois have developed a carbon-negative building material using seawater, electricity, and injected CO_2.

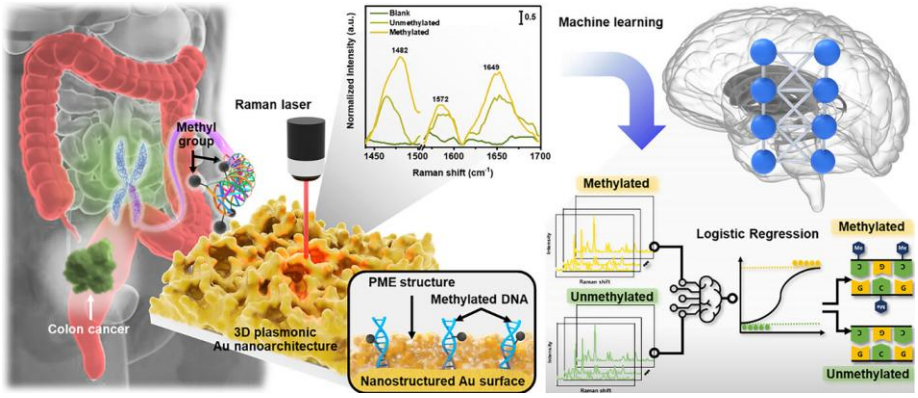
- **How It Works**
    - Using an electrochemical process seawater is split using renewable electricity, producing mineral deposits like calcium carbonate ($CaCO_3$) and magnesium hydroxide ($Mg(OH)_2$).
        - These minerals trap CO_2—up to 50% of their weight—by mimicking *how mollusks form shells*.
            - Side note: Mollusks build their shells using calcium carbonate, secreted by a tissue called the mantle.
                - The process involves precise crystal formation—either calcite or aragonite—arranged in complex microstructures that give shells their strength and beauty.
                - Studying this helps scientists understand how living organisms create hard materials, which has implications for bone growth, coral reefs, and even synthetic materials.
        - **How the Northwestern University team is creating a building material**: By adjusting voltage, current, and CO_2 flow, researchers can control the texture and density of the resulting material.
- **Applications**
    - Can replace sand in concrete, or be used in plasters, paints, and magnesium-based cement.
    - Offers a scalable method to reduce emissions in the construction industry, aligning with Net Zero by 2050 goals.
- Ongoing work aims to refine mineralization control and scale up production.

Story 4: Researchers develop a biosensor based on light and AI for early diagnosis of cancer

Source: MedicalXpress.com Story by Andrew Zinin

Link: https://medicalxpress.com/news/2025-07-biosensor-based-ai-early-diagnosis.html

See research paper here:
https://advanced.onlinelibrary.wiley.com/doi/10.1002/advs.202503257



- A research team from the Advanced Bio and Healthcare Materials Research Division at the Korea Institute of Materials Science have developed an optical biosensor capable of detecting trace amounts of **cancer cell DNA** in the bloodstream with high sensitivity, enabling early cancer diagnosis.

- Compared to *conventional liquid biopsy techniques*, this new optical biosensor offers superior sensitivity and specificity, and its standout feature lies in its ability to diagnose cancer early *using only light signals and AI-based analysis*, without the need for complex testing procedures.

    - **Side note** - Conventional Liquid Biopsy Techniques:

        - Today's liquid biopsy is a minimally invasive method that detects cancer-related biomarkers in blood, offering a powerful alternative to traditional tissue biopsies.

- **Key Highlights of the new Korean optical biosensor:**

    - The new technology combines plasmonic materials (which amplify light signals) with AI to detect DNA methylation—an early marker of cancer.

        - DNA methylation is a biochemical process where a methyl group (one carbon atom bonded to three hydrogen atoms) is added to the DNA molecule.

        - Abnormal methylation patterns are linked to diseases like cancer, heart disease, and immune dysfunction.

- **Sensitivity of the new optical biosensor:** Detects methylated DNA at concentrations as low as **25 femtograms per milliliter**—about 1/25,000th of a sugar grain in a drop of water.

    - **Side note:** a femtogram is one quadrillionth of a gram!

- **Speed & Simplicity:** Requires only 100 microliters of blood and delivers results in 20 minutes, without complex processing.

    - How the Test Works

        - A standard blood draw is performed.

        - The sample is processed to isolate plasma, where tumor-derived materials are found.

        - Advanced sequencing or molecular assays are used to detect and analyze cancer-specific markers.

- **Accuracy:** Achieved 99% accuracy in identifying *colorectal cancer* across all stages in a study of 60 patients.

- **Applications:** Suitable for hospitals, home diagnostic kits, and point-of-care testing.

- According to the Korean research team, their plans for this technology include expanding to address autoimmune and neurological diseases.

- This innovation could redefine how early-stage cancers are diagnosed, making screening faster, cheaper, and more accessible.

Honorable Mentions

Story: Worcester Polytechnic Institute Researchers Develop Cleaner, Scalable Process to Recycle Lithium-Ion Batteries

Source: WPI News Website Story by Colleen Wamback

Link: https://www.wpi.edu/news/wpi-researchers-develop-cleaner-scalable-process-recycle-lithium-ion-batteries

See research paper here:
https://www.sciencedirect.com/science/article/abs/pii/S2405829725003848

- In a major step forward for sustainable energy technology, researchers at Worcester Polytechnic Institute (WPI), led by Professor Yan Wang, William B. Smith Professor of Mechanical and Materials Engineering, have developed a new, scalable method to recycle lithium-ion batteries in a way that is both efficient and environmentally friendly.

- The team's research, titled Upcycling Mixed Spent Ni-Lean Cathodes into Ni-Rich Polycrystalline Cathodes, was recently published in Energy Storage Materials, a multidisciplinary peer-reviewed journal focused on the topics of materials and energy. The paper details an innovative hydrometallurgical upcycling approach that offers both environmental and performance advantages over traditional recycling methods.

- The process specifically targets spent mixed nickel-lean (Ni-lean) cathode materials, which are commonly found in used lithium-ion batteries. Traditional recycling methods struggle to recover these materials effectively and often rely on energy-intensive processes that produce lower-value outputs. In contrast,

Wang's approach recovers more than 92% of critical metals—nickel, cobalt, and manganese—and turns them into high-performance cathode powders.

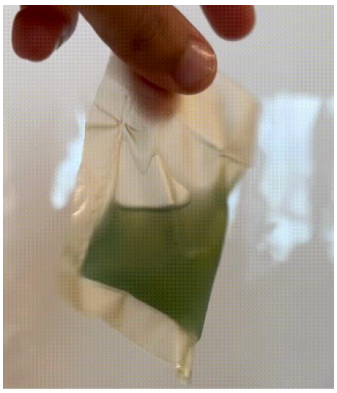
- Testing shows that batteries made with these recycled materials perform on par with those made from virgin materials, retaining 88% of their capacity after 500 charge cycles and over 85% capacity after 900 cycles in commercial-scale pouch cells. The new process also uses 8.6% less energy than conventional hydrometallurgical methods and significantly reduces carbon emissions—by 13.9% when compared with traditional recycling, slightly more than with direct upcycling.

- "This work not only addresses the environmental challenges of battery waste but also helps reduce our dependence on mining for critical materials," said Wang. "We've shown that it's possible to create high-performance batteries from recycled materials at scale, which is essential for building a more sustainable and resilient battery supply chain."

Story: pFIBRE Launches Scalable Biodegradable Films to Replace Single-Use Plastics

Source: ThePackHub.com

Link: https://thepackhub.com/innovation-news/pfibre-launches-scalable-biodegradable-films-to-replace-single-use-plastics/



- India-based materials innovator pFIBRE has unveiled a new range of plant-based packaging films that offer a sustainable and scalable alternative to traditional single-use plastics.

- Designed to fully biodegrade in both marine and soil environments, it is claimed that the new films leave behind no microplastic residues.

- The films disintegrate rapidly, within three days in water and seven days in soil, offering a fast end-of-life solution.

- Engineered to mimic the properties of conventional plastic films, pFIBRE's innovations are available in both water-soluble and water-insoluble variants to meet diverse application needs.

- Key Highlights of pFIBRE's Biodegradable Films:

    - **Rapid Biodegradation**: Certified for quick disintegration in natural environments without microplastic byproducts.

    - **Thermoplastic Compatibility**: Can be processed on existing plastic manufacturing equipment, requiring no retooling.

    - **Cost-Effective**: Up to 70% cheaper than other biodegradable alternatives, with no clean-up or disposal costs.

    - **Sustainable Feedstocks**: Produced using non-staple food crops with low water use, avoiding pressure on food supply chains.

    - **Carbon Neutral and Recyclable**: Offers full compliance with extended producer responsibility (EPR) regulations.

Story: Scientists Create Living Plastic Alternative - And it's edible, too!

Source: Futurism.com Story by Noor Al-Sibai

Link: https://futurism.com/scientists-living-plastic

See also: https://www.sciencealert.com/scientists-create-biodegradable-plastic-alternative-thats-literally-alive

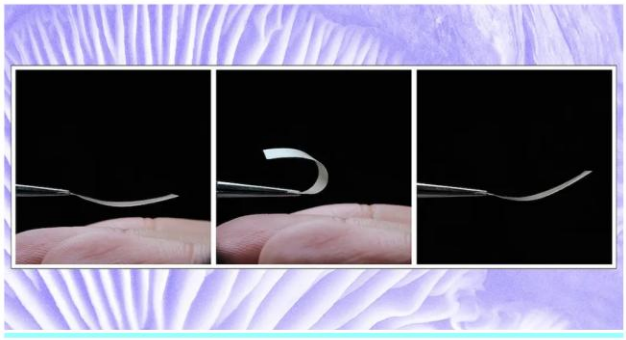


Image by Empa / Getty / Futurism

The split-gill mushroom has inspired a new biodegradable material. (Jayantibhai Movaliya/iStock/Getty Images Plus)

- Using mushrooms, scientists have created a living, plastic-like compound that uses the fungi's unique properties to mold it into almost any form.

- Researchers out of the Swiss Federal Laboratories for Materials Science and Technology, better known as Empa, have used the common split-gill mushroom to create what they're calling "living fiber dispersions" or LFD, a gel-like material that can be used as a plastic alternative in all manner of applications.

- The new material's unique strength and versatility come courtesy of fibers from the split gill mushroom's mycelia, or root-like structures — a popular subcomponent used in everything from eco-friendly packaging and textiles to green building materials and nutrient-dense food.

- In most modern applications, mycelial fibers are chemically treated and cleaned which the team says in a press release results in a "trade-off between performance and sustainability."

- Instead of treating the mycelial fibers, the Swiss researchers kept them whole and allowed them to grow an extracellular matrix, the "network of various fiber-like macromolecules, proteins and other biological substances" that gives fungi their structures and helps protect them from the outside world.

- After selecting a particularly sturdy and flexible strain of split-gill mushroom, the scientists whipped up their concoction in the lab and began experimenting with ways it could be used.

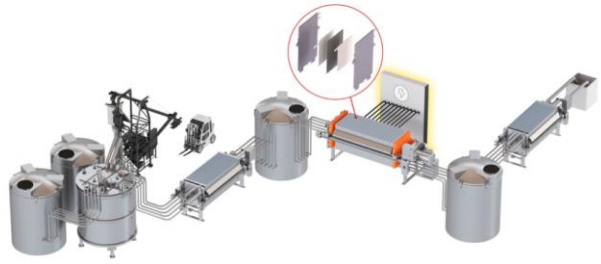
- Along with drying it into thin, tear-resistant strips that can be used for sustainable shopping bags, the researchers also demonstrated that their new material could be used as an emulsifier, or mixer, for food or cosmetic products. Because the split-gill mushroom is edible, that means any product made with it would be safe to eat and apply to the skin.

Story: Nth Cycle is bringing critical metals refining to the U.S. - the company is already producing nickel and cobalt from battery scrap in Ohio

Source: MIT News Story by **Zach Winn**

Link: https://news.mit.edu/2025/nth-cycle-brings-critical-metals-refining-0627

See also: https://nthcycle.com/



Instead of building a refinery, Nth Cycle's team has built a modular refining system — dubbed "The Oyster" — which uses electricity, chemical precipitation, and filtration to create the same metal refining chemicals as traditional methods.

Credit: Courtesy of Nth Cycle

- China is the dominant global supplier and refiner of several critical minerals—including **lithium**, **cobalt**, **copper**, and especially **rare earth elements (REEs)**

- Today the U.S. needs another technological breakthrough to secure domestic supplies of metals like lithium, cobalt, copper, and rare earth elements, which are needed for everything from batteries to jet engines and electric motors.

- An outfit called Nth Cycle thinks it has a solution.

- Nth Cycle, co-founded by MIT Associate Professor Desirée Plata, is pioneering a new approach to critical metals refining in the U.S. using a patented electro-extraction technology.

- Instead of building traditional refineries, the company developed a modular system called **“The Oyster”**, which uses electricity, chemical precipitation, and filtration to recover metals like **nickel and cobalt** from battery scrap and industrial waste.

- Key highlight: The system runs on electricity rather than fossil fuels, making it faster to deploy and more environmentally friendly than conventional methods.

- Here's how it works:

    - **Electro-extraction**: Instead of using fossil fuels or harsh chemicals, The Oyster applies electrical currents to selectively extract metals. Each cell in the system targets specific metals, separating them based on their electrochemical properties.

    - **Chemical precipitation**: Once metals are isolated, they’re precipitated out of solution using controlled chemical reactions. This step helps concentrate the metals into usable forms.

    - **Filtration**: The final step involves filtering out impurities, leaving behind high-purity metal products like Nickel Cobalt Mixed Hydroxide Precipitate (MHP).

- The company sees its technology as a strategic solution to reduce dependence on foreign metal refining—especially from China—and to position the U.S. as a global leader in critical metals production.