OPPORTUNITY #44

What if we could make new materials in seconds?

FRESH THREADS

Advanced machine intelligence enables novel algorithmic models and techniques for predicting how new materials will function, accelerating the discovery of new materials.

MEGATREND
Materials Revolution

TRENDS
Artificial Intelligence
HumanXMachine
New Materials
Quantum Technology

SECTORS AFFECTED
Agriculture & Food
Materials & Biotechnology
Automotive, Aerospace & Aviation
Chemicals & Petrochemicals
Communication Technologies & Systems
Consumer Goods, Services & Retail
Data Science, AI & Machine Learning
Energy, Oil & Gas & Renewables
Health & Healthcare
Immersive Technologies
Infrastructure & Construction
Logistics, Shipping & Freight
Manufacturing
Metals & Mining
Utilities

WHY IT MATTERS TODAY

Algorithms can push the boundaries of what can be achieved in materials science, by accelerating progress and unlocking materials previously unachievable by humans alone. Materials science and innovation are key to disruptive innovation. 3M and Hitachi are two companies that are frontrunners in materials innovation, each investing approximately $1.9 billion per year in research and development (5.9%[728] and 3.4%[729] of their revenues, respectively).

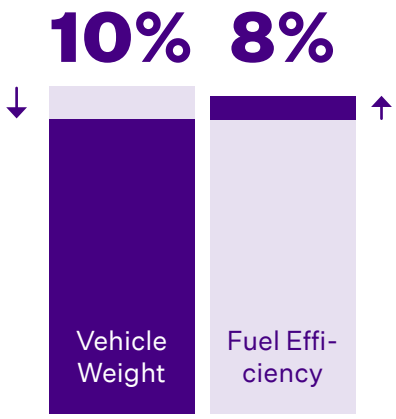
Materials science and innovation is also not new. Since 1859, scientists have been trying to achieve a single-layer material using chemical and mechanical methods involving expensive and specialised equipment, but it was not until 2004 that graphene was first isolated from graphite. Almost invisible, graphene is 200 times stronger than steel and is the most conductive material discovered to date, yet it is stable and non-reactive,[730] promising to transform sectors.

Materials science and innovation are also critical to decarbonisation[731] and transportation.[732]

For example, a 10% reduction in vehicle weight through the use of lightweight materials can result in up to an 8% improvement in fuel efficiency.[733] Using lightweight materials in only one quarter of US cars and trucks could save more than 22.7 billion litres of fuel annually by 2030[734] – that is, approximately 3.7% of the fuel these vehicles consumed in 2021.[735] Similarly, a 20% reduction in aircraft weight through the use of lightweight materials has resulted in up to 12% efficiency.[736]

The lightweight materials market is estimated to reach $279 billion by 2030, having grown from just over $172 billion in 2021 at a compound annual growth rate (CAGR) of 5.5%.[737]

Materials innovation also shapes the future of robotics,[738] smart materials and nanomaterials.[739] The market for robotics is expected to reach $214 billion by 2030, growing at a CAGR of almost 23%.[740] The smart materials market was valued at $5 billion in 2021 and is expected to reach $8 billion by the end of 2027, growing at a CAGR of 6.9%.[741] The global nanomaterials market was estimated to be worth nearly $10 billion in 2021.[742]



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in vehicle weight through the **use of lightweight materials** can result in up to an
8% IMPROVEMENT
in fuel efficiency

THE OPPORTUNITY

Currently even the most powerful Artificial Intelligence (AI) models used for materials science sacrifice accuracy for speed, which can prove problematic when materials are being designed to function in specific situations, such as in microelectronics.[743] Today, complex simulations – for example, of the properties of new metal alloys – can take days or even weeks to run, and it can take decades to develop new materials.[744] Further vast improvements are needed in advanced machine intelligence relating to materials.[745]

Improving accuracy and speed across property prediction, function and complex interactions could revolutionise fields such as medicine, energy, construction and aviation.[746] High-speed processors could run millions of simulations in milliseconds, enabling ultra-rapid design and testing of novel materials in multiple configurations.[747]

Novel algorithmic models and techniques for predicting how new materials will function could be used to improve materials discovery. These advances could make it possible to design, prototype and test new materials and properties (or optimise existing materials and properties) in highly complex environments – for example, in the engineering of biomaterials for organ repair or in carbon dioxide capture.

Such exponential increases in the speed and accuracy of materials modelling would result in reduced development costs, accelerated lab-to-market times and improved return on investment. Ultra-rapid advances in materials would drive breakthroughs in energy storage and transmission, transport, sustainable production and consumption and healthcare and well-being.

BENEFITS

Faster, more cost-effective development of new materials. Reduced environmental impact and more versatile materials. Ability to identify and address the potential risks of novel materials before widespread use.

RISKS

Delays to the regulatory reforms that would be needed to aid innovation and discovery of new materials. Use of advances to do harm.

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