

BUSINESS SWEDEN

INSIGHT SERIES 2019

MATERIALS OF THE FUTURE

TRUTH 4: TOWARD A HYPER-DESIGNED FUTURE

Materials engineers are always on the lookout for the next big thing. But customers are increasingly playing an instrumental role in shaping the innovation paths and materials that transform everyday life. In collaboration with Swerea, Sweden's world-class research group, and trend analyst firm Kairos Future, Business Sweden presents a special report in nine parts about the race for stronger, lighter, more sustainable, absorbable – and fully connected materials.

INTRODUCTION:
TRENDS AND TRUTHS IN THE
MATERIALS RACE

TRUTH 1:
DRIVEN BY CUSTOMERS FROM
HEAVEN AND HELL

Demanding customers who want more and pay less are a strong incentive for rapidly developing, new and better materials. This will lead to a future with higher degrees of collaboration with customers in order to understand their needs, ideally before they are aware of them themselves.

TRUTH 2:
ENVIRONMENTALLY FRIENDLY –
SUBJECT TO RESERVATIONS?
The materials of the future are obviously designed in environmentally friendly ways with lightweight, energy saving and low-carbon emissions at top of mind, but how simple will it be to recycle them? Complex, tailor-made materials place high demands on future recycling facilities.

TRUTH 3:
IN THE SHADE OF THE FOREST
The forest is a natural source of raw materials for much of what is made using oil today. Nations rich on forests have great potential for developing new, advanced materials industries based on raw materials.

TRUTH 4:
TOWARD A HYPER-DESIGNED
FUTURE
There is no reason to believe that the trend towards more intensively designed and customised products will slow down, quite the opposite. In future, materials may even be designed all the way down to atomic level in order to meet increasingly high demands.

TRUTH 5:
CONNECTED
Sensors can already be found on many products today, but in the future they will be embedded in materials to a far greater extent as woven fibres, smart coatings, conductive nanotubes or in other forms. The materials will be able to report fractures, overheating and other issues via the Internet of Things.

TRUTH 6:
BORN AT THE CROSSROADS
It is increasingly difficult for a single party to develop sophisticated and advanced materials. The materials of the future are therefore rarely born from a single company but in the interaction between several different parties, each with their own expertise, requirements and areas of strength.

TRUTH 7:
CREATED BY NEW PIONEERS
New players from the IT and space industry, among others, are beginning to drive material developments to a larger extent. They can often afford to manage major collaborations or, if necessary, develop what they need themselves. Pioneers from other areas are entering the materials industry, both as partners and as competitors.

MATERIALS OUTLOOK 2020:
WHERE ARE WE HEADING?

Join us as we explore the seven truths about the materials race in depth.
Go to www.business-sweden.se/en/invest/industries/new-materials

MATERIALS OF THE FUTURE, TRUTH 4

TOWARD A HYPER-DESIGNED FUTURE

There was once a time when every manufacturer was forced to choose between a limited number of materials including variants of steel, perhaps aluminium – or maybe between bronze or brass. The available spectrum of materials on offer was simple: steel, aluminium, copper and bronze. Just take your pick! But then eventually a smorgasbord of options began to emerge. And the choice today is seemingly endless.

In the future, we will not only select materials from an extensive menu of options but develop bespoke materials with made-to-order material variants. Materials are increasingly developed for niche applications that serve individual markets and customer demands. At the same time, the available choice has become both larger and smaller. Larger because almost any conceivable material can be designed, yet smaller because material variants are rarely optimised for specific purposes. This, however, is about to change.

The materials of the future will be hyper-designed for clearly defined purposes according to precise specifications. Super-materials do not emerge from a vacuum or in empty white laboratories. They are developed out of necessity in collaboration with end users and sometimes as part of a product or component. It is ultimately user specifications that define the boundaries.

Rethinking the forces of competition is necessary in order to meet new expectations among customers and end-users. But here is the conundrum: when materials are developed in different conditions, they also put new pressure on surrounding industries. How can this challenge best be tackled? The answer is by adoption a fresh mindset – by harnessing new expertise and knowledge levels among material developers and abandoning traditional approaches.

Take for example the rapid growth of customised materials in the automotive sector where global application of metal matrix

69%

of survey respondents stated that the materials of the future will be much more diversified and different from each another. Nearly as many, 67%, stated that the materials will be adaptable for various application areas.



composites has increased by 30 per cent over the past decade. The same applies in electronics where the use of matrix composites has doubled. Customised materials will only increase as new players have entered the market such as SpaceX, which develops materials for spacecraft under the guidance of some of the world's leading materials experts. Companies that can afford to pay can afford the best – and the best is almost always custom-made.

Material properties are likely to become a more decisive factor than what materials actually consist of. When we asked an open question about which materials and material combinations are most attractive today, the fifth most common answer was some variant of “materials with specific/customised properties”. This came after the four main materials; steel, composites, aluminium and plastic.

Materials are already often specialised in different ways in alloys, composite form or in some combination with one another. Customised materials are clearly at the forefront of thinking among many industry experts. Not to mention the fact that nearly 90% of the survey respondents confirmed that materials would become more tailored for specific purposes, a trend which seems inevitable for industrial applications.

DIVERSITY IS KING

When materials become more customised and intensively designed, they also become more diversified and different from one another. Seven out of ten consider this to be a major step-change. Experts who see a hyper-designed future ahead of them also recognise the increasing role of diverse materials for radically different application areas. At the same time, nearly seven out of ten acknowledge the large potential of adaptive materials fit for broad application areas.

More notably perhaps, nearly all survey participants agreed that materials will become increasingly designed for niche applications. In this sense, a paradox arises between niche materials and adaptive materials. Relative adaptability presents a third way where materials are developed with a specific sector in mind, yet adaptable enough to match different functions

within the relevant field. Design and appearance may be constant while weight, heat resistance and other features are adapted for each application. Apple is a good example where custom-made aluminium is adapted for slightly different properties in different products, while the design appearance is strictly kept in line with brand values.

While potentially a viable force, this broad functionality was only considered relevant right now by just over half of the survey respondents. Is it possible to have your cake and eat it too? Perhaps companies that succeed with this combination of broad and narrow will become the big winners of the future.

WHO INVENTS SUPER-MATERIALS?

How can materials be created that are both specialised and useful in a general scope of applications? Hyper-designed materials require both knowledge of materials technology and final product design – but they also require a

43%

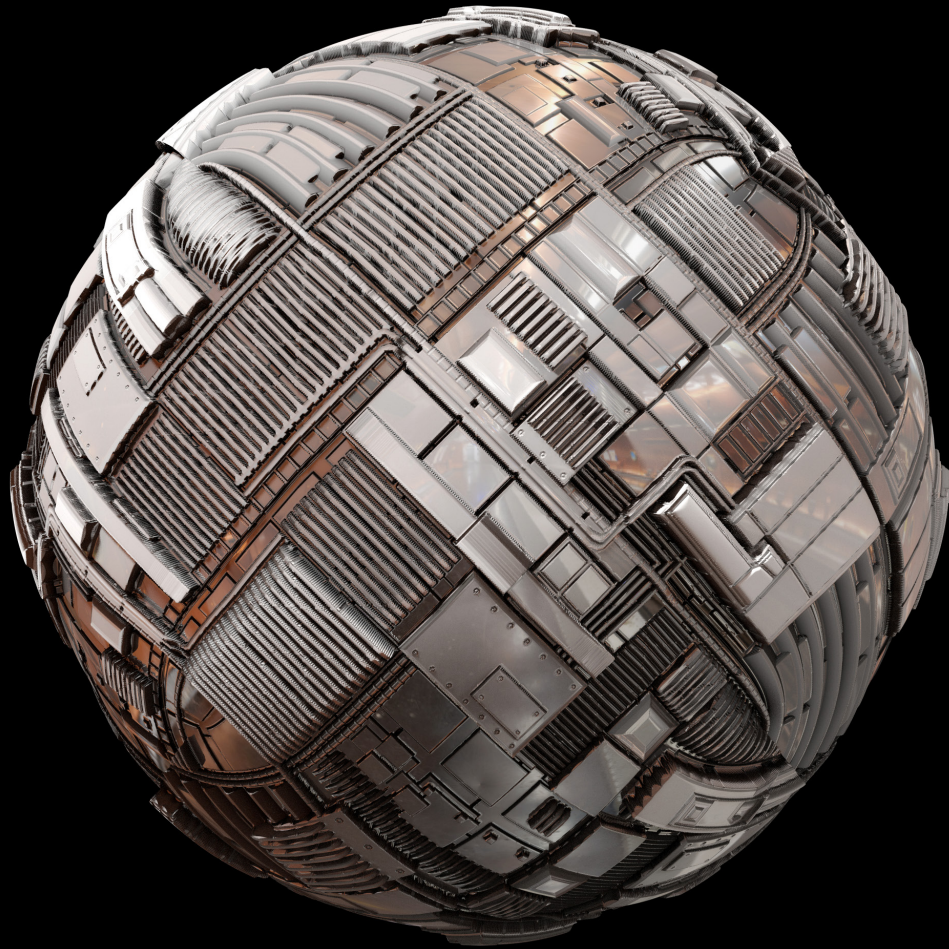
of survey respondents believe that strong positioning within niche areas is one of the greatest strengths of the Swedish materials industry.

Adidas, together with Alexander Taylor, has developed shoes in a seamless material combination in which the different materials are woven together as a composite rather than sewn, resulting in a shoe that is easy to shape based on the wearer's foot.

Ovako manufactures specialist steel for wind turbines made to withstand wear and heavy rotations. The purity of the steel means it is resistant for longer and requires less maintenance – critical to power plants that are expensive to repair.

Arcams EBM technology allows for the development of metallic microstructures. The material is formed layer by layer using CAD models and a specific 3D printing technique which is operated in a vacuum.

In a collaboration between concrete and graphene experts at **Chalmers**, preliminary results have shown that the strength of concrete can be increased by 40–50%. The results were achieved by modification of graphene in such a way that it binds with silicon and calcium oxide.



Space is cold, empty and menacing. There is a lot that could break, much that could go wrong – a sensor is small and delicate but ever so critical when it comes to detecting life-threatening damage to the hull of a spacecraft. But imagine if the entire exterior of the spacecraft was connected, not only a part of it? This future is not far away. Carbon nanotube sensors can already be embedded in materials as paper-thin leaves that detect leaks or gases anywhere in the spacecraft, around the clock. Smart sensors, like raisins in a cake, transform practically anything into a smart, connected version of itself.

more holistic view of how the industry works further down the value chain. The material industry of the future is likely to demand broader expertise and more cross-border collaboration in order to achieve custom-made materials that behave exactly the way customers want them to. There is still a long way to go until all materials are designed and managed at atomic level, but the majority of respondents believe that this could become reality within the next century.

As many as one in five of our survey respondents – all materials experts – believe it would be possible to achieve this level of specialisation within 15 years. This will probably require major restructuring and new partnerships. But achieving such a level of materials control is not beyond reach, and there is much to be gained for developers who get there first.

STEPPING INTO THE NICHE MARKET

Niche materials already play a key role in global manufacturing. Four out of ten respondents believe that a strong position within specialised areas is one of Sweden's greatest strengths, especially in custom-made steel and materials for the automotive industry. In an increasingly globalised world with fierce competition in materials development, this might be a strength worth nurturing, as a way of expanding into new niches.

Good knowledge of customer needs and product requirements is a major strength according to more than half of the survey respondents: it is the sixth most important benefit out of 18 options. More investment in the field may not be necessary: out of 16 of the proposed strategies for the future “more customised materials” came second to last. The conclusion, therefore, is that the

32%

of survey respondents confirmed that increased demand for specialist materials is one of the most important driving forces behind materials development.

DEVELOPMENT RATE FOR VARIOUS MATERIAL PROPERTIES*

Properties	Expected acceleration rate
Easier to recycle	102%
More bio-based	63%
More environmentally friendly to manufacture	40%
More environmentally friendly to use	33%
More adaptive to different areas of applications	27%
Broader functionality (several practical functions)	24%
More difficult to use, requires more from the user	20%
More diverse and different from each other	18%
More stable and stronger	17%
Lighter (weighs less)	15%
More difficult to manufacture, requires more precise properties	13%
Cheaper	11%
More difficult to choose	10%
More customised and intensively designed	10%

*According to survey carried out by Swerea (www.swerea.se/sites/default/files/the_future_of_materials_swerea.pdf)

materials industry is already relatively strong in this area, but not safe from being outpaced by others.

Lack of cross-collaboration is considered a major threat to material manufacturing, and in a world with increasingly integrated material research and development of materials internally, it is easy to fall behind – why buy Swedish steel if you can get your own materials made according to specification? More than half of the respondents believe that Swedish material manufacturing needs to continue to apply its strengths to maintain momentum, by exploring new markets and applications in areas where Sweden excels and stands out.

YEAR 2030:

NO MORE ONE-SIZE-FITS-ALL

Better sensors and improved manufacturing technologies have resulted in better materials which, of course, is an obvious development. However, 15 years ago we could hardly imagine the level of control we currently have – in certain industries there is practically no difference between developing products and developing materials. They have become part of the same industrial process. The products are near seamless and the materials invisibly transition from soft to hard, using special finishes and microscopic changes.

Where three materials were needed in the past, it is now sufficient to use three variants of a single material specially designed for aircraft wings, engines, shoes or screens. While some industries still use standard materials, this is usually for cost reasons. Superior quality cannot simply be bought off-the-shelf.

STRATEGIC RECOMMENDATIONS

- Keep in mind that materials cannot be created out of thin air but must meet specific requirements from customers and end-consumers. Make efforts to understand the requirements and how to fulfil them rather than creating a material that is “good enough”.
- Find the niches where materials can be best put to use or the niches that still lack sufficiently advanced materials and create a roadmap for development. Understand both directions of the value chain and try to help suppliers and researchers to better meet customer needs.

89%

of survey respondents stated that the materials of the future will be far more customised for specific areas of usage.



The combination of design and science is greater than its parts – one plus one equals three.

Anders Breitholtz, Managing Director, Material Connexion Sweden



SWEDEN – A NATION RICH IN FORESTS AND MINERAL RESOURCES

Sweden is Europe's leading mining nation and a global forest industry giant. These natural resources formed the bedrock for Sweden's industrialisation. And they remain important today. But times are changing. Digitalisation is eroding demand for newsprint and new technology is driving innovative applications for traditional metals and high-tech metals. Sweden hosts mineral deposits like graphite, lithium, rare earth metals.

The shift towards sustainable development and renewable materials is transforming the forest industry to a stronger orientation towards higher value products. Innovative companies are using Swedish wood to develop new bio-based materials such as barrier films, chemicals, carbon fibre, textile fibers and other applications with industry-changing potential.



ABOUT THE AUTHORS

Swerea (now RISE Research institutes of Sweden): In 2018 two thirds* of Swerea was acquired by RISE Research Institutes of Sweden (RISE), continuing its scientific work as a part of a total force of 2,700 researchers and experts with extensive industrial knowledge and experience of how to accelerate research results into innovation for practical use. RISE is a unique mobilisation of resources with the aim to increase the pace of innovation in our society. It is owned by the Swedish State and work in collaboration with and on behalf of the private and public sectors and academia, with the ability to take on a variety of roles in the innovation system.

** 1 third of Swerea created the new metal research institute Swerim.*

Kairos Future: Kairos Future is an international consulting and analysis firm that helps companies take leaps towards the future. Through trend and scenario analysis and support in innovation and strategy, we help customers with the big picture and the direction for the future. Kairos Future was formed in 1993, our head office is situated in Stockholm and we have partners worldwide.

Business Sweden: Business Sweden helps Swedish companies grow global sales and international companies invest and expand in Sweden. We ensure that international companies can rely on our knowledge, experience and extensive network to identify new business opportunities and achieve an accelerated return on investment. Business Sweden is present in 50 of the world's most promising markets and owned by the Swedish Government and the industry, a partnership that provides access to contacts and networks at all levels.



We help Swedish companies grow global sales and international companies invest and expand in Sweden.

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