

BUSINESS SWEDEN

INSIGHT SERIES 2019

MATERIALS OF THE FUTURE

TRUTH 5: THE AGE OF CONNECTIVITY

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:
THE AGE OF CONNECTIVITY
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:
THE RISE OF 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 5

THE AGE OF CONNECTIVITY

The materials of the future will be digitally-enabled. This does not mean they will consist of ones and zeroes – but data is likely to form an integral part of many materials as the physical and digital worlds combine. Everything talks with everything in the future and this shift is far from unexpected given the pace of digitalisation in society today.

In fact, sensors can already be installed almost anywhere. At the same time, sensors are themselves just another form of material that detects changes such as elasticity, temperature, vibration and more, and converts these to electrical impulses. So why have a separate sensor? Why not design materials with embedded sensor capabilities using changing conductivity when materials are cold, warm or bent?

We have already started experiments in this field and the boundaries are becoming blurred. How do you distinguish a material from a sensor when the material is sometimes almost as complex, with several layers of composites with

different properties? The solutions may differ but the conclusion is the same: the materials of the future will be connected, in one way or another.

What does this mean for the materials industry and development? That remains to be seen. But we know that major changes will take place as customer expectations on monitoring of both materials and products in real time accelerate. In the short term, the impact on the materials industry may be limited, but revolutionary trends quickly become hygiene factors and materials that are not smart enough will, in due course, find it difficult to compete. That said, it is hard to predict just how materials will become digitised. Change is happening at a different pace in different industries and what seems obvious to materials experts in the fashion industry may be irrelevant to furniture manufacturers. However, there are interesting indicators that reveal the kind of changes we can expect from the connected future.

71%

of respondents to our survey believe that high technical expertise is a crucial strength for Sweden's materials industry.

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Comfortable textile fibres can act as sensors and still be washable. The sensors can register small strains that arise from e.g. heart rhythms, Parkinson tremors, or pressure when someone is lying in bed. When mankind loses focus, materials will still be there doing their job!

Pernilla Walkenström, Senior Vice President, Bioscience and Material, RISE

DIFFERENT MATERIALS, DIFFERENT VOICES

A majority of our survey respondents believe that half of all sports garments sold in Sweden will contain sensors embedded into the fabric within 15 years. This would mean that fabrics with sensor potential would, more or less, be the norm by 2030, at least for some garments. Looking only at answers from people in the textile industry, they believe developments could move even faster and most of them are forecasting widespread use of sensors within ten years or less. The same applies to hospital beds that monitor patients' body temperature – this, according to the majority of respondents, will be the norm within 10 to 15 years' time.

Most, however, are sceptical that it will be possible to equip materials with sensors at the time of extraction from the soil, but three out of ten can envisage such a future within 30 years. While it is difficult to create a consistent picture of the connected materials of the future, we know the opportunities are huge. How this trend develops depends on industrial and geopolitical factors and, not least, the evolution of customer demand and needs.

Many of the respondents confirm that sensors are an important and vital opportunity for their industries – whether related to biosensors, smart metals or plastics or the monitoring of maintenance in order to prevent material fatigue. Digitalisation is not a driving force in itself, at least not according to the survey findings, but it does change perspectives in terms of what materials can do.

INSIGHT INTO THE LIFE OF MATERIALS

Connected materials are also valuable for developers and manufacturers. Sensors not only provide users with knowledge, but also insight into the material itself – how it is used, the challenges it encounters, how it wears, how it is stretched and strained.

The tools for measuring and evaluating materials are becoming more sophisticated and with smart and connected materials, these measurements do not necessarily have to take place in

laboratories. Instead, they can be carried out in the real world by customers and end consumers. This will unlock access to deeper knowledge about materials performance in practical terms and the value chains – perhaps the entire way from the mine to the end consumer if materials are monitored and evaluated throughout their lifecycle.

CONNECTED MATERIALS IN SWEDEN

High technological expertise is the greatest strength of Swedish materials development and, in the survey, seven out of ten consider this to be a key advantage. Sweden also has advanced digital expertise with a leading IT sector and a vibrant start-up community. The question is whether this expertise can be channelled and co-ordinated from different fields to speed up the shift toward digitised materials.

Increased focus on industry-related research is the fifth most preferred strategy out of 16 in our survey for improving the materials industry – and many consider smart, connected materials to be an essential opportunity.

65%

of respondents to our survey consider it probable that half of all sports garments sold in Sweden will contain sensors embedded directly into fabrics within 15 years. 39% believe it may happen within just ten years.

54%

of respondents to our survey considered it likely that Swedish hospital beds will consist of materials that can measure patients' body temperature, within 15 years.

Vaporsens has developed an electronic nose, consisting of sensitive materials that detect gases and vapours. The secret is a specific nano-fibre material.

Swerea IVF has developed piezoelectric fibres which are electrically conductive and able to measure heart and lung activity via a sweater. The material can be used in healthcare as well as in sports.

ChromoGenics has developed a system for electrochromic windows, which can be connected to regulate the amount of light and heat that is let through. The material can be linked to sensors for dynamic adjustment of indoor temperature.

Google's Project Jacquard is developing touch-sensitive fabrics that function as touch screens. This is possible thanks to conductive fibres woven directly into the fabric – commands can be programmed and performed, for example by touching a lapel.



Microlattice is a strong material structure which is as light as a feather. A one-centimetre thick block of the material can rest on a dandelion and comprises 99.9% air, but it is strong enough to be used in aircraft structures in the future. The idea is simple: an airy design inspired by animal bones. But it took many people to invent and manufacture it – people from two universities and a research institution, sponsored by Boeing and at the initiative of the US Department of Defense. *Microlattice* may be unique in many ways, but like many of the materials of the future it was born out of collaboration.

YEAR 2030: THE HOLY TRINITY OF INDUSTRY

By 2030, materials, products and services will have merged in a holy trinity that guides industry. Even if it is possible to differentiate between them, they are still inseparable from one another as all three are digitally traced throughout the value chain. A piece of material is already connected in the manufacturing process and is ear-marked for the end customer. It retains its identity through the design process to the finished product and continuously communicates with the outside world, particularly product manufacturers who want to ensure that they are offering the best possible solutions.

If a product is damaged or incorrectly used, it can be easily fixed. Fifteen years ago when we talked about smart materials it was like the parable of the blind men and the elephant – a small part of a much larger picture, an uninterrupted digital flow that we could not even imagine.

STRATEGIC RECOMMENDATIONS

Make sure that all materials, including the most traditional and simple materials, do not escape digitalisation. Seek out partnerships with IT-savvy partners to understand how digital technologies can strengthen and improve materials and material knowledge today. Be prepared for rapid innovation when it comes to connected materials – keep an ear to the ground and adapt development strategies on a running basis.

29%

of respondents to our survey believe that it will be possible to equip all raw materials with sensors when they are extracted from the ground within 30 years.

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In three dimensions you can see the crystal structure and chemical composition, providing new clues for how materials should be designed. This application is about to revolutionise analysis methodologies. Deformation processes can be filmed so we can watch and see what happens when materials are under strain.

Anders Jarfors, Professor, Jönköping University

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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