

## A Cellulose-Based Society

Special issue about Innventia's third global outlook and the new research projects generated by the report

BioLi2.0 - from lignin to biobased fuels and chemicals

3D-printed prostheses based on forest raw materials

New group of IPMA certified project managers

Innventia Days 2016 and the TechMark Arena



# A Cellulose-Based Society

"A Cellulose-Based Society" is the name of our third "Innventia Global Outlook" report in which we have surveyed attitudes towards materials that we all use in everyday life and described the trends and driving forces shaping the way towards a more sustainable future.

What are the conditions for a vital social transformation – from a fossil-based and linear society to a biobased and circular society? The starting point of "A Cellulose-Based Society" was the long-term relationship of mankind with the forest, a complex, challenging, intriguing story which is still under development. We studied the opportunities and challenges facing society today to formulate questions for experts in the development of new materials, new technologies and new business solutions. And we asked consumers in five countries around the globe to imagine a future in which resources from the forest are used to create the most diversified array of products – just about everything from textiles and vehicle parts to food, cosmetics and prosthetics.

"At Innventia, we are working for a biobased, circular economy based on renewable raw materials from the for-

est," says Birgitta Sundblad, President of Innventia and Manager of division RISE Bioeconomy\*.

"Cellulose has a number of applications, from paper and packaging to modern materials in our buildings and cities. When the natural building block of cellulose is used in the service of people, things start to get really interesting: cosmetics, food, clothing and medicines are just some of the opportunities we see. This is what we call A Cellulose-Based Society."

Swedes most positive about new products from forest resources

In cooperation with Kairos Future, 2,500 consumers from Sweden, the United States, China, Germany and Brazil were asked about their thoughts and attitudes to sustainability, the environment, materials and impact.

Overall, there is a huge desire among consumers to shop in an environmentally responsible way. And it is through their consumption and lifestyle choices that people see the best opportunity for directly impacting on the development. Another view that unites all countries is that "creating more effective material recycling systems" is highlighted as by far the best measure for making the world more sustainable; this is in competition with eleven other measures such as "Tax CO2 emissions harder", "Invest in new energy sources", "Ban environmentally harmful substances in products" or "Tax travel and transportation harder".

A future in which the forest becomes a more important resource in the manu-

facture of materials and products seems to be strongly polarizing. The view of the forest and its role in our communities touches us, and awakens strong feelings, and the differences between countries are huge. In Sweden, a large majority are positive about such a development. Even in the USA, positive reactions are in the majority, but in Germany, Brazil and China about half of those surveyed are more critical and concerned about what a move towards a more cellulose-based society would mean.

"The industry is facing a significant communicative challenge," says Birgitta. "Consumers want to understand the significance of the bioeconomy and do the right thing, but those of us who develop and produce new biobased solutions need to get better at both explaining how they affect the planet and communicating the sustainability aspects."

"The consumer survey clearly shows that we are aware that our lifestyle is affecting the planet. But we are unsure about what exactly we should do about it," says Marco Lucisano, the project manager of A cellulose-Based Society.

Eight trends that frame conditions moving forward

The trends (see also page 4) in the report highlight changes in the world that are already shaping the future of mankind and that will have huge significance on the transition to a more sustainable society.

*The City Norm* puts the focus on how the speed and scope at which humanity is now crowding into cities is going to reshape and redefine our future.

\*) The RISE institutes SP, Swedish ICT and Innventia are merging in order to create a unified institute sector and become a stronger innovation partner for businesses and society. Innventia Group operations will entirely be part of division RISE Bioeconomy.



The cover of the report was made on Innventia's pilot paper machine FEX. The paper is made from 100% recycled material consisting of equal parts textiles (old jeans) and paper fibres.

Left: Innventia Global Outlook A Cellulose-Based Society was released in May 2016 during the The International Wood Biorefining Week in Stockholm. Among the speakers were President Birgitta Sundblad and project manager Marco Lucisano.

PHOTO: JENS REITERER/IWB

A more comprehensive publication of the consumer study will be released during European Paper Week 22–24 November in Brussels. At the same time, it will be downloadable on [www.innventia.com](http://www.innventia.com). "The survey as attracted a lot of interest and this is a way for us to meet this interest," says Market Director Fredrik Rosén.

## Innventia International Consumer Survey 2016

The international consumer study in figures.

- 62% of Swedes say they are positive about development towards a more cellulose-based society. 31% say they are upset, angry or worried.
- A clear majority in all countries believe that consumers themselves have the greatest responsibility for the environment through their consumption and lifestyle choices.
- People in Brazil are most concerned about environmental issues (76%). Sweden is least concerned about this on an international comparison (26%)
- Swedish consumers are in third place on the question of buying environmentally friendly alternatives. At the top come China (48%), Brazil (46%), Sweden (21%).
- Consumers in Brazil have the worst consciences (41%) when they don't shop in an environmentally-friendly way (China 34%, USA 17%, Sweden 14%, Germany 4%).
- 51% of Swedes say that the material played a role in their latest purchase (China, with 80%, followed by Brazil, with 74%, rank even higher).
- The material that consumers in all countries say they want to avoid most is plastic. Most valued are natural materials such as wood and wool.

For more information such as graphics etc., see press material on [www.innventia.com/cbs](http://www.innventia.com/cbs).

*The Need of Nature* shows how natural values do not reduce but rather increase as people become increasingly urbanised.

*No Waste* describes how increasing resource constraints and increased costs of waste management strengthen the impetuses for development towards an increase in reuse and recycling – with huge public support and ever stronger financial incentives.

*Econsumers – Econscious and Ecofused* points to how a growing number of consumers are committed to environmental and sustainability issues – and would be glad to pay a little extra for these values. At the same time, it is increasingly difficult to determine what “the right choices” are in a world where more and more goods are produced as “sustainable”.

*No More Plain Janes and Average Joes* portrays a development in which an increasingly heterogeneous mass market splits into a myriad of fast-moving niches, and where the “average consumer” as the target group is irrelevant.

*Shift Happens* describes how entry barriers and economies of scale are becoming less important in a globally competitive landscape where new technological and business opportunities are creating entirely new industries and players, while others quickly perish.

*Business Activism* illustrates a trend in which companies, on both business and ethical grounds, start to take an increasingly active role in the pursuit of a sustainable world. This has a particularly large impact at a time when both politicians and consumers are perplexed and disagree about the challenge of leading development in a positive direction.

“Both the survey and trends show overall that the really successful brands and organisations will be those with the ability to actually demonstrate groundbreaking ideas and concepts in reality for consumers. We call this the Demonstration Economy and understanding this is the key to social transformation,” Marco concludes. ●

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## The Demonstration Economy

The trends describe a world with huge shared social challenges; where the needs and requirements become increasingly diverse and fast-changing; where new technological and business opportunities create completely new conditions, challenges and needs; and where innovation and new thinking are a prerequisite for success. The trend section therefore ends with the conclusion that the successful organisations and companies of tomorrow need to build skills that go beyond thinking through promising ideas and concepts – many people will be increasingly good at that in the future. The truly successful organisations will be those that also have the ability to demonstrate these ideas and concepts in reality. The force for change, as well as the success, that can be created by the ability to demonstrate solutions that can actually be seen, touched and experienced can currently be exemplified in organisations such as Uber, Airbnb, Tesla, SpaceX and Khan Academy – organisations that have all changed the perception of what is possible and desirable, and shaped the reality around them.

*Demonstration is the key to success – welcome to The Demonstration Economy!*



### ”A Cellulose-Based Society”

är namnet på vår tredje rapport i serien “Innventia Global Outlook” där vi kartlagt människors attityder gentemot material som vi alla använder i vardagen och beskrivit trender och drivkrafter som formar vägen mot en mer hållbar framtid. I samarbete med Kairos Future genomfördes en konsumentstudie i fem länder. De åtta trenderna beskriver en värld med stora gemensamma samhällsutmaningar; där behov och krav blir alltmer heterogena och snabbföränderliga; där nya tekniska och affärsmässiga skapar helt nya förutsättningar och utmaningar behov; och där innovation och nytänkande är en grundförutsättning för framgång. Organisationer som utöver att skapa idéer också har en förmåga att demonstrera dem i verkligheten, kommer att vara de framgångsrika.



## On our mind

In the report *A Cellulose-Based Society*, we have identified eight trends. On our website you get the opportunity to deepen your knowledge of trends in a series of interviews with our experts. A sneak peek of these interviews is presented below.



“Many companies that focus on the traditional volume products are facing huge challenges and need to find ways of balancing both volume and niche products to achieve profitability. Given a history with an extreme focus on volume, this will be a challenge for many. However, we can expect to see both new business models and exciting cooperation in the future to deal with this.”

Fredrik Rosén about the trend  
*No More Plain Janes and Average Joes*



“This trend sees activists and politicians facing competition from large, strong companies that want to do good. They have the resources not to have to worry about quarterly reports, and they dare to make huge investments in what they believe in: green energy, circular business models, alternative solutions that benefit everyone, not just the company. They create goodwill while also putting pressure on other companies.”

Dina Dedic about the trend  
*Business Activism*



“More new and exciting partnerships will lead to more sustainable and service-focused products and will engage consumers. The individual is growing closer to industry and taking a larger role by being an active participant in the value cycle. Products are being designed to be recyclable and reusable in order to circulate materials many times.”

Tatjana Karpenja about the trend  
*No Waste*



“We believe that there is a lot to be done to guide the conscious but confused consumers, for instance using informative labelling. When we discuss this trend, we may start by asking ourselves the question: “What would I need to consume more eco-friendly?”

Fredrik Aldaeus about the trend  
*Econsumers: Econscious and Econfused*



“An open, strategic mind-set and the ability to search out and apply the core competences of an organization in new areas will likely be the successful remedy to handle the shifts to come. Those who lack these skills will not enjoy the coming years.”

Konstantin Sundin about the trend  
*Shift Happens*



“Mega city states will become more common. The question is what influence will satellite towns or the countryside have? What does this mean for the forestry industries?”

Mikael Lindström about the trend  
*The City Norm*



“We work with innovations in different ways. One way is within our research programme where different companies work together around common issues in our pre-competitive part of the programme. Another example is our collaboration with universities of Art, Craft, Design and Architecture – many of our demonstrators stem from these collaborations.”

Therese Johansson about the trend  
*Innovation by Collaboration*



“It is clear that nature does not just inspire us with its strengths, but also promotes cities from a sustainable business perspective. A Swedish example is the housing company Bonava, which transformed the otherwise concrete landscape of Sergels Torg, one of the most vital areas in Stockholm, into a green area for a day.”

Marco Lucisano about the trend  
*The need of nature*

Current awareness from the Innventia Group



## 'A Cellulose-Based Society' generates three new research projects

The 'Cellulose Fibre materials', 'Cellulose for the Future' and 'Paper mill for textile recycling in the circular economy framework' research projects have recently been launched as a direct result of 'A Cellulose-Based Society'. The preliminary studies from these projects will result in, among other things, proposals for our next research programme, which starts in January 2018.

### Cellulose Fibre materials (CelFi)

"The project focuses on scaling up All-cellulose composites (ACC) – a hot-pressed, high-density cellulose material. An increased understanding of the properties of ACC material and the scope for upscaling also provides us with important knowledge for continued development of other types of hot-pressed cellulose-based materials, such as hybrid laminate consisting of a core containing cellulose and a metal skin. Potential applications include modern materials for buildings and cities," says project manager Elisabeth Sjöholm. ●

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### Cellulose for the Future (CelFu)

"One of the challenges of research into cellulose is that the amount of new materials is often limited. This project will facilitate, in various ways, the creation of technology and a knowledge platform for research and upscaling for separation of fibres and wood components within the 1-10 kg range. The focus will also be on establishing cooperation and partnerships with academic research groups," says project manager Katarina Ohlsson. ●

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### Paper mill for textile recycling in the circular economy framework (Circular Fibres)

"The project is evaluating the techno-economic and sustainability performance of a new concept for paper production. The work focuses on new paper materials where a significant proportion of the fibre raw material consists of low-grade fibres from textile recycling plants. During pilot testing at Innventia, we previously proved that it is technically possible to manufacture paper with attractive material properties from just such raw materials. Based on the framework for a circular economy, this involves so-called 'cascade recycling' of fibres from the textile industry to the paper industry. You can experience the new paper in the cover of the 'A Cellulose-Based Society' report, which is Innventia's demonstrator of potential applications for this exciting new material," says project manager Tatjana Karpenja. ●

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**Tre nya** forskningsprojekt har startat som en direkt effekt av "A Cellulose-Based Society". CelFi-projektet fokuserar på uppskalning av ett kompositmaterial av varmpressad cellulosa med potentiella applikationer inom konstruktion och samhällsbyggnad. CelFu kommer att arbeta för teknologi- och kunskapsplattformar skapas för forskning och uppskalning av separationsprocesser. Circular Fibres ska utvärdera tekno-ekonomisk och hållbarhetsprestanda av ett nytt tillverkningskoncept för nya pappersmaterial där en väsentlig del av fiberråvaran består av lågvärdiga fibrer från textilåtervinningsanläggningar. Utifrån ramverket för cirkulära ekonomi innebär det kaskadåtervinning av fibrer från textilindustrin till pappersindustrin. Förstudierna inom de tre nya projekten ska bland annat mynna ut i förslag till vårt nästa forskningsprogram som startar i januari 2018.

## COMING EVENTS

### NOVEMBER

- 16-18 6th International Symposium on Food Packaging
- 22-24 European Paper Week
- 28 Seminar/exhibition Finlandshuset: New ways to use cellulose
- 30 3rd WOTIM Training Module and final conference

### MARCH

- 28-30 7th Nordic Wood Biorefinery Conference

### APRIL

- 2-6 ACS National Meeting & Exposition

For further information on coming events, see [www.innventia.com](http://www.innventia.com)

## The 7th Nordic Wood Biorefinery Conference

28-30 March, 2017  
Stockholm, Sweden



The 7th Nordic Wood Biorefinery Conference will present the latest ideas and developments in biorefinery separation and conversion processes as well as new bio-based products from the wood biorefinery: energy, chemicals and materials.

### Among the speakers

Professor Oded Shoseyov,  
University of Jerusalem

Professor Magda Titirici,  
Queen Mary University of London

Richard Gosselink,  
University of Wageningen

Niklas von Weymarn,  
Metsä Group

Anders L Larsson,  
Valmet


Martheus antunes Guimaraes,  
Fibra

For more information, see  
[www.innventia.com/nwbc2017](http://www.innventia.com/nwbc2017)





## BioLi2.0



Project kick-off at Innventia 20 September, 2016.

PHOTO: FOTOGRAF JOHAN OLSSON

# From lignin to bio-based fuels and chemicals

The new BiInnovation project "BioLi2.0 – From lignin to bio-based fuels and chemicals" will develop processes for the production of fuels and chemicals based on renewable lignin as a replacement for fossil fuels and petroleum-based products.

The use of oil is constantly increasing in the world. To meet the challenge of increased emissions of carbon dioxide it is necessary to increase the use of renewable raw materials with shorter

**The use of lignin from forest materials is expected to contribute to increased sustainability in Swedish society in many ways:**

- Reduction of carbon dioxide emissions from the transport sector and from chemical products.
- Replacement of fossil-based raw materials with renewable material contributes to increased sustainability.
- More secure energy sources by the use of Swedish resources and raw materials.
- New business opportunities for the industries involved (primarily the forest industry and the petrochemical industry in the refinery sector).
- Potential to use the techniques developed in order to tap into other sources of lignin from other processes.

life cycles. For plants the life cycle is between less than a year and a few decades.

Lignin as a renewable resource has great potential for the chemical and petroleum industries. Lignin is the second most common component after cellulose in plants and functions as a skeleton. Around 20-30% of trees and other plants consist of lignin. Lignin is used on a large scale today in the pulp- and paper industry for producing steam and electricity, but through energy savings, greater effectiveness and the use of other side-streams from the forest for energy production, the potential for other uses is large and increasing.

"By using new chemical processes, that will be developed by the project, the lignin can be extracted, refined and modified so that it has similar properties, and will work as an alternative, to petroleum raw materials like coal and oil," says project manager Marie Anheden.

### Upscaling and evaluation

One goal of the project is to develop chosen technologies and establish value chains for lignin, as well as to increase the technological maturity level – from development on a small scale to the demonstration of prototypes in relevant industrial environment.

The project will contribute to establishing a first demonstration plant, which can exemplify a full value chain from lignin to final product in the form of chemicals or fuels, to be in production

in Sweden within five years of the start of the project.

28 parties from industry, research institutes and universities are involved in BioLi2.0 which covers the chain from raw materials to products via chemical processing and purification.

"Our aim is that the project will contribute to development and scale up of new processes and also evaluate the technical and economic potential for different value chains," says Marie Anheden. ●

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The project will run for 2.5 years and has a budget of 46.9 MSEK. It is financed by Vinnova, the Swedish Research Council Formas and the Swedish Energy Agency as well as the participants in the project.



**"BioLi2.0 – Från lignin till biobaserade drivmedel och kemikalier"** är ett nytt projekt inom det strategiska programmet BiInnovation. Inom ramen för projektet ska företag, forskningsinstitut och akademi under 2,5 år samarbeta för att utveckla processer för framställning av drivmedel och kemikalier baserade på förnybart lignin som ersättning för fossila, petroleum-baserade produkter. Projektet kommer att ledas av Marie Anheden från Innventia och har en total budget om 46,9 Mkr. Projektet ska bidra till att ha en första demonstrationsanläggning för hela värdekedjan från lignin till slutprodukt i form av kemikalier eller drivmedel, i drift i Sverige inom fem år.

# 3D-printed prostheses based on forest raw materials

The AMPOFORM project will develop technical solutions for printing prostheses manufactured from forest raw materials such as nanocellulose and lignin-based carbon fibre.

“Our goal is to combine 3D printing with cellulose-based materials for additive manufacturing of prostheses,” says Li Yang, a project manager in graphic technology and optical calibration at Innventia. “Through this, we will bring together both materials and technology that are at the forefront of development, something that is an exciting challenge. At the same time, we want to create a new value chain for healthcare, with various businesses working together on several fronts.”

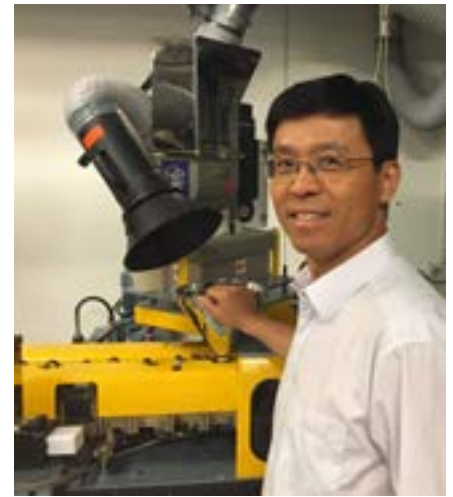
The production of prostheses currently mainly uses fossil-based materials, such as thermoplastics and carbon fibre. The manufacturing process is often complicated, requiring a lot of manual work and experience. The AMPOFORM project intends to simplify prosthesis manufacturing, something that will save time

for both technicians and patients. The ability to undertake individual customisation will increase significantly, while manufacturing costs will fall and the prostheses themselves will become more environmentally friendly.

“With this project, we want to contribute to the long-term sustainability of the public healthcare sector,” continues Li Yang. “The use of biobased materials in 3D printers also opens up the possibility of other products that were previously impossible or too expensive to manufacture in the traditional manner. Our vision is for Sweden to become a global leader in additive manufacturing in the long term.”

Nanocellulose and carbon fibre from lignin, among other materials, will be used in 3D printers for the prostheses. Additive manufacturing involves less consumption of materials and this, together with the time savings, also provides economic benefits. Overall, prosthesis manufacturing costs can be reduced by up to 50 per cent.

“Improving the properties of 3D structures is one of the challenges of the project. We will also evaluate both the



3D-printer technology and the production process and marketing requirements within the healthcare sector,” concludes Li Yang. ●

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AMPOFORM stands for Additive Manufacturing of Prosthetic Products Based on Forest Raw Materials. Innventia is the coordinator for the project, which runs from June 2016 to May 2019. Other participants are Stora Enso, Wematter, Fillauer Europe and Orthotics/Region Örebro County, all with leading expertise in both biobased materials and 3D printers and prostheses and orthotics. Of the total budget of SEK 11 million, 44 per cent is being provided by Vinnova.

# New group of IPMA-certified project managers at Innventia



13 of the certified project managers together with the course supervisor from Innventia Marco Lucisano and the instructor Mattias Ejbe from Astrakan.

Recently, 15 of Innventia's project managers concluded their training in preparation for the prominent certification. The course, which started in autumn 2014, has been tailor-made for Innventia, with IPMA as its foundation, supplemented with the relevant ISO standards for projects at the company.

At a time when project clients are increasingly asking that projects are led by certified project managers, Innventia has chosen to offer its employees training for IPMA\* certification. This is an internationally recognised standard that provides the company with a competitive advantage and offers a natural career step for project managers. Behavioural expertise is an important component, as the importance of leadership behaviour increases.

“It is really pleasing that we already have a number of certified project managers, and that we shortly will have several more,” says Anders Pettersson, Innventia Senior Vice President.

The training was aimed in part at programme area managers for Innventia's Research Programme. One of them is Astrid Odeberg Glasenapp, manager of the programme area Boosting packaging performance.

“The basic concept is that we will all use the same models, procedures and tools, but that the exchange of experiences between one another will also be facilitated. In the long term, I think we will be faced with more clearly expressed demands to be certified when leading major projects.” ●

\*) International Project Management Association (IPMA) is an umbrella organisation for project management associations around the world. IPMA certification is internationally recognised. Project managers certified in Sweden receive certificates in both Swedish and English. Read more about IPMA at [www.ipma.world](http://www.ipma.world).



## Have you changed address?

Let us know by sending an e-mail to [info@innventia.com](mailto:info@innventia.com).

# B



# Innventia Days 2016

The event on 27-28 September presented latest research findings, an introduction to the new RISE and an exhibition from the TechMark Arena at the premises of the FEX pilot facility.

Innventia Days 2016 offered an introduction to the new RISE Research Institutes of Sweden with Pia Sandvik talking about how we can become a stronger partner to Swedish industry through the merger of SP Technical Research Institute of Sweden, Swedish ICT and Innventia to form RISE.



Pia Sandvik, Managing Director at RISE

Our visitors also heard about our third Innventia Global Outlook report, A Cellulose-Based Society. The focus then shifted to subjects such as the circular economy, textile-like materials that are produced on our paper machine, digitalisation within the pulp and paper industry, and additive manufacturing. All the presentations were further enriched by knowledge from invited experts, a concept that was appreciated by the participants who had the oppor-



There was a great chance to mix and meet both old acquaintances and new people.

tunity to pose questions both to the speakers and to the invited experts.

The second day was dedicated to research results from Innventia Research Programme 2015-2017 and was open to the 34 funding companies.

“Planning has recently begun for the next three-year programme, which starts in 2018. The whole of Innventia is now becoming part of the RISE Bioeconomy division and, together with another 100 or so employees within related fields, will now be able to offer a broader, more focused programme to our existing and new customers,” says Innventia Senior Vice President Anders Pettersson.



Anders Pettersson

We asked some of our visitors what they will take away with them from Innventia Days. Find out what they answered at [www.innventia.com/innventiadays2016report](http://www.innventia.com/innventiadays2016report). ●



### Innventia Days 2016 bjöd bl.a.

på en introduktion till nya RISE, Research Institutes of Sweden av vd Pia Sandvik och resultat från Innventia Global Outlook rapport A Cellulose-Based Society. Därefter lyftes ämnen som cirkulär ekonomi, textillika material som tillverkats på vår pappersmaskin, digitalisering inom pappers- och massaindustrin samt additiv tillverkning. Vår transdisciplinära exjobbskola TechMark Arena fick även möjlighet att presentera cellulosabaserade material för additiv tillverkning och liknande formningsmetoder inom 3D. Andra dagen vigdes åt forskningsresultat inom Innventia Research Programme 2015-2017.

## TechMark Arena 2016

Our transdisciplinary academy for thesis students, TechMark Arena, showcased cellulose-based materials for additive manufacturing and similar methods within 3D during Innventia Days. Below are some examples from the exhibition.



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