

*Tämäkin ohjelma on Suomen Podcastmedian tuotantoa.*

*Fiber futures.*

*SUSTAFIT Project*

*Litteraatti - Fiber Futures - 2. Boost for nonwovens from sustainable innovations*

Virpi Rämö:

In this podcast we will explore how sustainability transformation takes place in the fascinating world of non-wovens. We use and benefit non-wovens in our daily lives, but sometimes they are not that visible for us as consumers. In this series, I will interview different actors working towards a more sustainable future of non-wovens. My name is Virpi Rämö, and I lead a research project, Sustafit, focusing on sustainable and fit-for-purpose non-wovens funded by Business Finland. Today I have the pleasure to talk to two highly-acknowledged impact leaders within the non-woven research from two continents. Welcome Dr. Behnam Pourdeyhimi, Distinguished Professor and Executive Director of the Non-Wovens Institute, U.S. and Dr. Ali Harlin, Research Professor at Technical Research Center of Finland, VTT. Welcome. So, let's start by asking that if you would need to select a single hottest research team within non-wovens currently in the U.S., what would that be, Venampurdei?

Behnam Pourdeyhimi:

Yeah, there are actually quite a number of them, but if I had to pick one, I would say what we now call advanced chemical recycling. It seems to be really quite promising in the sense that you take the materials and you can essentially chemically sort them and convert them back to monomers that are indistinguishable from the virgin materials. And so you won't have two different sources of raw materials. And there are significant investments by some of the major organizations in the world, both in Europe and the U.S., focusing on that. And so I think that is going to be really interesting to watch.

Virpi Rämö:

Yeah, that sounds really interesting and important. Then I cannot wait to hear your thoughts, Ali. What about in Finland or in Europe? What would you highlight?

Ali Harlin:

In Europe, there is quite some political guidance around the topics. And there is the Green Deal, as they call it, and it has come out with several things like a single-use plastic directive and so on. And the basic idea has been to reduce or replace the use of plastic. And that is a political decision. Of course, pretty much the same technical developments and economical dependencies can be seen in Europe as in the U.S. or all around in the developed world. But anyway, it has started from the plastic waste issue and that has caused a certain development, which is now followed by other materials made from the same polymers. And recycling, reuse are the key keywords there. But of course, non-woven, all the textile or the fiber is coming a few years later than the plastics in that. But plastic is the driver. They are the developers of the recycling or the reuse of the materials. In Europe, maybe we are focusing even on the top of that alternative raw material base, which is the difference.

Virpi Rämö:

In this episode, we will explore how innovations and especially sustainable innovations are reshaping the non-woven industry. So what is driving the green transition in the non-woven sector and especially what happens in the research in this field, since that is where you see probably best what is going to happen in the next phase and what's bubbling under the surface. Let's start by talking a bit about the product innovations. COVID pandemic made it very easy for us consumers to know first of all what is a non-woven, since we all had masks on our faces. And that's a nice example of what non-woven can do, but that's of course not the whole story. There are a lot of ways we can benefit non-wovens. So could you tell maybe one example of a specific non-woven product or application you think is fascinating or super innovative?

Ali Harlin:

In the big picture, non-woven is extremely flexible so that it can be used as an innovative material in nearly all the known areas. So it is very difficult to pick up some. So you mentioned filtration. Yes, that is one of the topics which are very difficult to handle without non-woven structures. Of course, there are attempts to look at again after a few years that could nonwovens be used in actual clothing applications or kind of say long lasting applications where has been used to say more expensive materials are pretty much fascinated by many companies because the cost competition is always around. And then in the consumables like hygienic products and so on so that there is the real battle ongoing now. So what is the right way to go and what is the choice where they say acceptable and for consumers as well say understandable solutions for sustainability. So it is very difficult to pick only one.

Virpi Rämö:

Yeah, that's right. Thanks for raising up this clothing sector. I like that idea since there is a lot happening on that side in Finland in general. So nice to keep also the non-wovens in mind when thinking about sustainable clothing. But what would you want to highlight, Venampurdei?

Behnam Pourdeyhimi:

I think there's probably hundreds of examples that one could cite. But since we're talking about material sustainability, I'm going to cite one that I think has been really an interesting experience to watch. A few years ago, the Keurig patents ran out and so the whole world has started making single serve coffee capsules. And there are tens of billions of these capsules used. And of course, the housing is plastic, the lid is plastic and the non-woven is a filter. And these were made from completely incompatible materials. You had polystyrene as the base material, multi-layer polyolefin films as the top and then a variety of different filters. Within three years, and of course it was encouraged by the consumer, also by some government legislation, especially in Canada, the pods now have become completely compostable. And some of the best leading companies in the world started really switching to these and that trend continues. And they're all still made from non-wovens, but it's a different brand of non-woven. They had to do a lot of engineering to get these materials to work. But the will was there, the opportunity was there, and it's happening already.

Virpi Rämö:

Yeah, thanks. That was really interesting also for us Finnish people who are known to be heavy coffee drinkers. So really nice to hear that story. So then if we look more focused on

the sustainable innovations, which I think both of these already were sustainable, it's really important to start from the definition. So what actually does sustainability mean? So maybe you could, Ali, briefly define sustainability for us.

Ali Harlin:

God, grief, that's a tough question. Like say it's a systemic thing, and it is as well a developing target. So that earlier it was linked to, say, to certain raw material or like delivery chains or whatever, and waste management. But it's even more coming to the CO2 emissions, it is already there, it's coming to the same biodiversity, et cetera, so that when we are reaching one level, it's adding another one. But basically it's coming to just say how our consumption is in balance with our environment.

Virpi Rämö:

Yeah. Would you, Venampurdei, want to highlight any extra point to this?

Behnam Pourdeyhimi:

I do. I think defining the problem is half the solution.

Behnam Pourdeyhimi:

And sustainability by itself means absolutely nothing. And I think when we put it in the context of what we think, people think about material sustainability. But sustainability really goes far beyond that and beyond. And the sustainable development idea from the EU really encompasses many, many other things. But coming back to what's really relevant for us, I think, in terms of what we're talking about with regards to non-wovens, there are several things that we're thinking that are really critical. And one is not just plastics, but it's really the microplastics and nanoplastics that you find that are proven to be health hazards. But then we're really looking at CO2 emissions, we're looking at the usage of water, and we're looking at energy and energy use. And so you really have to look at all of these. And so when it comes to materials, you have to look at the entire lifecycle and make sure that we understand that and then put it in the context of sustainability.

Ali Harlin:

On your permission, I would like to add one viewpoint on the top of that.

Virpi Rämö:

Sure.

Ali Harlin:

So agreeing, yes, all that is essential and valuable, and we are focusing on that. But we are discussing very little about the consequences of consumption. So there is some kind of assumption that there is a zero-effect consumption. It's never going to be. And it's a balancing of the consequences of the consumption and the benefits. And in nonwovens, like if we are using it for personal hygiene or medical health care, there is a huge surplus to use or in filtering to have clean air or clean water. And so why we are using it, that has a net positive effect, and the consequences have to be in a balance with those achieved benefits.

Behnam Pourdeyhimi:

That's a really good point. I'd like to follow up on that, because our industry has begun to really think in terms of what we consider to be essential. And so look at medical gowns, look at all of the medical products, the wound care products, the respirators versus perhaps the wipe that we use at home.

Behnam Pourdeyhimi:

And so we are now beginning to look where we should focus.

Virpi Rämö:

Yeah.

Behnam Pourdeyhimi:

And I think make sure that we don't make decisions without looking at the consequences of those decisions.

Virpi Rämö:

Yeah.

Ali Harlin:

Yeah. And if I put that in a little bit more common terms, so that if you like to try to make a single use shirt out of the non-woven, you are not necessarily making the best possible thing in the world. If you make a product with which in an operation theater you can save a person's life, it's nearly impossible to calculate the total net positive effect. So it's very complicated, and we are missing in the LCA calculation the real measures, how to compare.

Ali Harlin:

We started because of the petrochemical industry, actually the oil industry started to calculate the LCA, and it's still so much only focusing even the system is capable of taking all the consequences, but focusing on the CO<sub>2</sub>, and that is like a bit twisting the picture. We should start to look at much broader and look at the systemic level.

Virpi Rämö:

Definitely. I'm relieved that you also feel that this question is difficult and there are many aspects to it, since I also feel that sustainability is super difficult to define, so how can you find solutions for it? What do you think? Do the companies also see sustainability very differently, or is there some kind of alignment where to target?

Behnam Pourdeyhimi:

There is, and I think if you look at, and they all actually publish their goals, and partly I think because of the environmental pressure and the political pressure that exists, but also because they really want to educate the consumer, and so if you look at the goals that exist within really the leaders in the non-wovens sector, one, reducing the carbon emission is of significant importance, with goals of becoming zero or negative by a certain date, and of course companies are different in terms of their goals, but reducing the emissions is really number one. Really looking at our impact on the environment in terms of the water consumption, so many companies are now looking at a net zero consumption, that is if you are using a certain amount of water, that you generate a certain amount of clean water that you can make available, because water is really a scarce commodity, especially in certain

parts of the world. They are looking at alternative materials, if we can do it with naturally occurring materials like pulp and cellulose, and if those materials work, I think we should look at them, and people are doing that already. They are also really looking at energy consumption, reducing energy consumption, which really dovetails back with the CO2 emission, and then of course we also use a lot of chemicals like these fluorinated polymers and things of that sort.

Behnam Pourdeyhimi:

So if they are using these polymers or these materials, they also have a goal of becoming PFAS free, and so I think everybody really speaks the same language, but some prioritize one more than the other, but I think they are all really pushing in the same direction.

Virpi Rämö:

Yeah.

Ali Harlin:

So here we consider the technology now. Plastic, as it says, is a material which is easy to convert, has taken a huge advantage in converting technologies because of that, so typically many other materials are very difficult to convert, and that is why melt spinning or melt spun lace materials, they are like having a real competitive edge, and that is economically a very viable thing to be understood, and if we consider that we could replace the polymers, which are like a typical petrochemical polymers, so we can of course make them more bio-based or more recycled content, which is of course making them in a calculation more attractive, but still they are the same materials, while particularly what happened when the single-use plastic directive came out in Europe was to define the plastic in a totally new way, non-scientific way, but new way, and it was saying that if you take from nature a polymer and you make any modification where you form a covalent bond, so basically you modify it, it becomes a plastic, so this is causing a huge confusion on what is possible, because there are bio-based polymers which are reasonable alternatives, of course very expensive, that's another point, but technically possible and like PHAs and so on, they have a capability to biodegrade, they are processable and so on but like we have really a big problem around the thermoplastic bio-based polymers, what shall come out, and at the same time there are developing processes for cellulosic materials, ready fibers, natural polymers, et cetera, but like already said, they are then causing certain concerns on the processability. So either way, competitive way you come up, you have a lot of development to be done, and that is why we should have a really, really, really clean statement, what the state, what the people, what the customers really want to have.

Virpi Rämö:

Ali, I still want to ask from you, since we are in Finland, and I personally feel that we are sort of in a sustainability bubble, we are very conscious and under the European strongly coming legislation supporting sustainable transformation, so what do you think, are the Finnish companies aligned?

Ali Harlin:

We are living in the middle of the forest, from the forest, and that is what we only see, the trees in the forest, so that is the perspective.

Virpi Rämö:  
Yeah.

Ali Harlin:

And the world market on non-wovens is huge and growing still quite nicely, so there is a space for specialty products as well, and the volume of cellulose or whatever we can produce is just negligible of the volume, so in that means that we are dark green, is really, say, understandable from our standpoint on this peninsula.

Virpi Rämö:

If we talk more about the raw materials, so as heard, raw materials is a big thing in nonwovens changing for more sustainable raw materials, and there is a lot of research in this area, companies are spending a lot of money and research efforts to find new or more sustainable raw materials, so I again want to ask if you would need to pick one good raw material for non-wovens, what would you like to pick and for what reasons?

Behnam Pourdeyhimi:

I am going to pick three actually.

Virpi Rämö:  
Alright.

Behnam Pourdeyhimi:

If you look at, there are many reasons why people are focusing on different problems, so what we are talking about is really waste that we are not managing, this is waste that ends up in the ocean, this is waste that ends up in the backyard, ends up in the forest somewhere, and so ends up in the landfill perhaps, and so there are different approaches to solving these problems, and Ali mentioned PHA, so there is a significant effort ongoing with respect to the family of PHA polymers, because these are truly marine biodegradable, and also the way they are formed, it is not really a petrochemical, they are formed by using bacteria, so there are significant developments. Kimberly Clark announced a partnership with RWDC, they are building a huge facility in Singapore for scaling up their PHA family of materials, Nature Works that makes the PLA product announced a joint partnership with CJ Bio, a Japanese company that makes PHA. There are significant activities in Europe around PHA family of polymers, and so they are really addressing the unmanaged waste that goes into the ocean, and then you have really what we call home compostable, so these are things that you could put in your trash and ultimately they go away, like cellulose does, and so there are activities to really make PLA home compostable. And it has been demonstrated there is a significant body of literature out of Dublin, Ireland, that came out that demonstrates you can do that, so they are really addressing that, and then last but not least there is a really new development, it is called biotransformation.

Behnam Pourdeyhimi:

There are certain products that are really essential as we spoke about, that cannot be made by using any other polymers, even if we could make them from other polymers we don't have enough volumes available commercially to make them. So companies have started collaborating on this biotransformation, the technology came out of Imperial College London, where you can essentially take a polymer like polypropylene, which is a petrochemical based

material that is heavily used in non-movements, and by adding this additive under the right conditions, it causes a catalytic conversion and it essentially makes it biodegradable and home compostable.

Virpi Rämö:  
Yeah.

Venampurdei Himi:

If that really works, that is going to be interesting, because it would be a very quick solution to a very big problem, so there are multiple approaches that people are taking that are really interesting to note.

Virpi Rämö:  
Yeah.

Ali Harlin:

They are coming to have certain challenges with the officials, particularly in Europe. The new directives, they take an extremely strict way to handle chemicals, which are like degrading the polymers, because there were earlier the oxy-radical materials, which are really questionable on the health side, and the promises which have been seen in early stage biopolymers like the PLA, they have not really been as effective in degradation, and now if the first things failed or were not really taking all the promises, now has been taken a few steps backwards. The readiness to take a risk is really, really low in Europe, so that is, I would say, a big difference in attitude on politics in different continents.

Virpi Rämö:

Thanks for bringing up this interesting PHA and home compostable and biotransformation, so ways to get rid of the polymer or non-woven product after its use, really interesting, and also that there are some challenges related to that. Would you, Ali, maybe want to add anything on the list of super raw material for non-wovens?

Ali Harlin:

Obviously, I'm working with cellulose, and my daily work is to understand what new we do with the cellulose. In the past, say, 10, 15 years, we have learned more about the cellulose as a material and its inherent properties and behavior, so there are many things which are as well, like if we're speaking about absorption of fluids or forming of gels, like release or capture of them, so it's not only natural-based and biodegradable, but it's as well functional. When you start to build on the, say, synthetic polymer, the same functionalities, then it as well requires a lot of things, and the question is on which level of functionality we want to be in our new products.

Virpi Rämö:

I was wondering that now there are many of these very highly scientific new approaches to sustainable raw materials for non-wovens, and I have seen that the companies have challenges in taking in these nice new raw materials into their, as the raw materials. There is availability, they are not exactly the same as the old raw materials they are used to working with, so what do you think, how can the companies tackle these issues and really get to use new raw materials? What kind of support do they need or what would be the approach to

take in new raw materials?

Behnam Pourdeyhimi:

Yeah, one of the challenges that we face in the non-woven industry is that it's highly capital intensive, and most of the machinery, they have been designed to really process materials like polypropylene. And as you move from that to something like polylactic acid or PHA or other materials, the machines don't simply work, and it would be a difficult task to ask for capital costs to simply replace the material, so the ideal goal would be to be able to produce something similar on existing machinery, and that requires a lot of really polymer modification, process modification. It's a challenge, but it's something that's already happening. I think in our facilities we have been dealing with biopolymers more than anything in my entire life and entire history, in the last two years, three years, and so there's really a significant level of help needed from technical organizations to help solve some of the basic problems that exist, and I think you see that happening.

Virpi Rämö:

Yeah.

Ali Harlin:

You are very right, so that the scale, the competitiveness of the existing production equipment is really devastating for the new materials. It's a little bit like you are trying to come to an Indy 500 and you have a tricycle, so the possibility where you can come up is that you choose a small specialty product, you learn there, you make the demonstration, and because these processes, what we have today, they have taken about 50 years to develop on the level as they are, so we need at least 30 years to make the same happen with the new materials. We have to have some kind of kindergarten for the new products and new materials, where they start first to crawl and run and finally jump.

Virpi Rämö:

I guess both of you have many experiences of making this kind of kindergarten for new materials, and you have seen some growth stories of new innovation getting into the reality, so what kind of support is needed by the companies, what kind of support can we give to the companies to get new sustainable innovations in reality?

Ali Harlin:

So politicians have given their support, so they have given play rules, but if they go for it, then they should also support the research and also the demonstration activities.

Companies, I think that if there is a customer who is willing to pay, they run for it, and if you cancel the customer, they will be there, no doubt. That is their work, they are logistic machines and they go for it.

Behnam Pourdeyhimi:

I think we have to be really careful when we set policy and not look at the unintended consequences of those policies. There are certain products that we cannot replace with any other material today. Again, the medical products are a good example because even if we could, if you take the PHA and say, we can replace them with PHA tomorrow.

Behnam Pourdeyhimi:

Even if PHA was at the same cost, it will take many, many years before we get there, and there is a simple reason for that. That the amount of PHA available in the world would be less than 0.0001% of what the industry needs, and so therefore someone, somewhere has to make these huge investments, and I think we should really advocate our governments to perhaps start thinking in that direction.

Virpi Rämö:  
Yeah.

Behnam Pourdeyhimi:  
Because it would be difficult for a single corporation to spend hundreds of billions of dollars in scaling up some of these new materials, so if we are really serious about this, we should be partners and come together and develop policies and then provide the support that enables these companies to do what we want them to do.

Ali Harlin:  
And sometimes it is even unrealistic that we expect that the existing leading companies will not take them as the dominant things on their production lines. So in a pharmaceutical sector, typically when you invent a new molecule, you have the phases to test it, and it should not have been that complicated with the materials, but we need startups, we need AJVs and so on, where these things can be developed and taken in use without the typical pressure of the market as it is every day, so the margins in non-woven industry, they are thin, and you have to be extremely capable in processing and with your material bending and everything, so that you can do it.

Virpi Rämö:  
Yeah, so the legislative aspect is super important here. What do you think about this research aspect, since you both work heavily with research, so what is the best way to support the companies with research? What is a good example of working research to make innovations reality effectively?

Behnam Pourdeyhimi:  
I think one of the things that is happening also in our industry is that they are moving towards zero waste. These processes produce a significant amount of waste, as much as 15 or 20%...

Virpi Rämö:  
Yeah.

Behnam Pourdeyhimi:  
... by mass, and we call them edge trim because we trim the edges of these rolls of materials that we produce, and so most often these are functional materials that are made from two or more materials that may or may not be compatible, so you cannot simply take them, regrind them mechanically, and put them back into the system, and so that is really one big area that the industry is looking at, and how do we take these incompatible materials and really recycle them and put them back into the system, and that requires really modification of the rheology, doing some chemistry, and sort of developing a way in which we can do that.

Virpi Rämö:  
Yeah.

Behnam Pourdeyhimi:

The largest nonwovens producer in the world is actually almost there, and they make these incompatible materials, and all the materials that are used to end up in the landfill are now actually being recycled and put back into the same material, so that is really one big area that I think is very significant.

Virpi Rämö:  
Yeah.

Behnam Pourdeyhimi:

Then really looking at, again we touched upon it, this new generation of materials, how do we process them, how do we make them so functional, so that they provide the same level of performance as existing materials, and so there is certainly no shortage of activities that we could be engaging in.

Virpi Rämö:  
But do you think, Ali, is there something where research is very essential for the companies?

Ali Harlin:

So, where I see that both are doing very marvelous results, so research is going deeper and deeper, and we know much more than ever, and faster is growing the knowledge, while at the same time the businesses are getting more and more efficient. But the question is we have some kind of a dead valley in between. So that I use a lot of my time in my work trying to convert the scientific findings or results, what is their meaning in common terms, that they can be used, so that the same finding you can use in trimming the efficiency to a certain extent, or like making some kind of a reorient of the product, so adding a new feature on your product, or then creating a totally new one. But you cannot make them all mixed at once and at the same time, but it has to be very clear and proven that what is possible, what is not possible, and provide that information to the companies that they really can do their best.

Virpi Rämö:

That is super important and really needed since we are talking about complex issues and difficult terminology, so making it understandable, that's a really, really important point.

Ali Harlin:

And of course, researchers are asked some kind of a responsibility or so on, so we don't always understand what is the outcome, all outcomes that we have found out, and all the things can be used right or they can be used wrong. So like for the plastics has been granted at least four Nobel Prizes in chemistry, at least. And they have been seen as the survivors of the planet because they reduced the food losses, et cetera. But at the same time, it is very difficult to predict what the outcomes are, and that is why we have to continue the development all the time, so we are never ready with it.

Virpi Rämö:

Let's go a bit back to the companies and their agendas. So there are many things happening in the research and the companies are driving the research, of course, to make business. But how high in priority do you see sustainability in companies' agendas and strategies? And now it's really nice to hear the viewpoint from different continents and different countries. I assume there might be differences. So, Behnam Pourdeyhimi, how do you see in the US how high in priority is sustainability?

Behnam Pourdeyhimi:

Yeah, so the industry has many forums that they get together. But in the US, we have one technical forum that we co-organize with our non-woven association once a year. And for the past 10 years, the topic of sustainability and materials and redesign of products has dominated the theme of the conference.

Virpi Rämö:

Yeah.

Behnam Pourdeyhimi:

So this happened even before the EU directive. So the industry is well aware of the challenges with the climate and roles and responsibilities. The PHA family of products, if you look at the patent literature, Procter & Gamble, has more patents in that area than anyone else going back 30 years. And so they were really looking at this, and if you walk through Procter & Gamble, they have a hall where they demonstrate how natural materials could be used in some of the consumer products they produce. So the industry is well aware. But I think what's happening now is beyond what we talked about is the product redesign. So we're looking at that diaper, for example, and then looking at do we have to make the entire diaper disposable or are there certain components that can be replaced so that we minimize the amount of waste that we generate, for example. So we're looking at redesigning the products with the end of life in mind. We're looking at redesigning materials for more than a single use. We're looking at reusable products. And so in the wipes domain, for example, it's already happening.

Virpi Rämö:

Yeah.

Behnam Pourdeyhimi:

It happened in Europe about 30 years ago where there were non-woven reusable wipes. But it's now really taking over in the U.S.

Virpi Rämö:

Yeah.

Behnam Pourdeyhimi:

There's a lot of dialogue about these kinds of things. But of course, we also have to look at how that material is used. And so do we now create a problem by laundering these and creating another waste stream? And so one has to also be careful because, and of course, I'm not sure in Europe, but at least I know in the U.S., all of the medical waste are

incinerated. And so we just burn them. And so that's not what I'm talking about. What I'm talking about is really the consumer. And then we have the industrial type...

Virpi Rämö:

Yeah.

Behnam Pourdeyhimi:

... of materials like wipes that we use. So there's a lot of trends that are happening. And I think the industry has been aware and will continue to really push on this front.

Ali Harlin:

From the company perspective, I fully agree that companies know all the things and they follow that time. It's their duty for their owners to know what are the possibilities and what are the risks. So I was in the petrochemical industry earlier. And like 30 years ago, we already knew that the time will come when we start to speak about recycling plastic. And we knew all those tricks that are now coming up. So it is a little bit coming down to what the customer is really requesting from the companies. And there are different customer groups so that, of course, nobody is going to sell directly to consume anything. So there are some other companies in between who decide what they're offering. So in Europe, what we see is that, OK, we have discussed the political will already quite some. So it's strongly green. But at the same time, the consumers are a little bit in between the chairs so that the reasons why they are buying something are still the same. So it's price, it's usefulness or that I really love that product. Sometimes in color, in nonwovens, the color is typically anything but white. But then it's the companies which purchase and define the real application for the nonwovens, the converters. They are pretty much on the driving seat so that they can turn that waking up of the consumer's awareness on sustainability to real products. So awareness is there, but the willingness to pay off it or saying as well the availability of the material is still limited.

Venampurdei Himi:

So I'd like to add one comment.

Virpi Rämö:

Yeah.

Behnam Pourdeyhimi:

I think something that's happening globally, especially in the US and Europe, is that we are looking for the low-hanging fruit. What can we do today that would really make a difference? If you look at all of the pictures of the waste that we see coming to our shores, and if you look at a lot of that waste, most of it is plastic packaging. And so if you look at the big consumer companies are focusing on that because that's something that we could easily replace because some of the materials that you can't really form a fiber and then a non-woven out of, you can make a packaging out of. And biopolymers, for example, have been used in that area very, very significantly. Cellulose has been used in packaging very significantly. If you look at some of the goals of these companies in order to make an impact on the environment is to replace the plastic packaging that they currently use with something that is not plastic.

Virpi Rämö:

Yeah.

Behnam Pourdeyhimi:

And I think that could be a significant opportunity, certainly for cellulose.

Ali Harlin:

We look at the originator of the plastic waste problem. It's definitely the packaging. Even more, the packaging film is like the tip of it.

Virpi Rämö:

Yeah.

Ali Harlin:

Typically, it's coming from the five rivers on a globe, which are typically in developing countries, where waste management is not in place. And many of these waste or side problems which are related to use of plastic are much easier or fully handable in the developed countries where we have the afford and capabilities and we have the systems. But like when saying that there is coming in a packaging also the reusability. And that is an aspect which we don't have in nonwovens easily, even if the nonwovens are in a packaging zone. Actually, the reusable packages are many times made out of the nonwoven.

Virpi Rämö:

So as you see what happens in the research and all the things we've discussed today. So do you see some kind of bigger change coming? We are talking about sustainable transformation in many contexts. And transformation for me sounds like some massive change of things or the word transformation is also being used. So do you see something coming in the near future because of climate change and because of the research that's being done and the mega trends? What do you anticipate would be coming as a transforming thing in the nonwovens?

Behnam Pourdeyhimi:

Well, I think the use of alternative materials is going to really be dominating what's happening in the area because sometimes we don't control the policy makers and what policies they make. And so I think you're going to see a lot of focus on that. But I also want to mention another area that I think needs perhaps another discussion another day. And that is the whole world of textiles are really very significant in terms of the pollution of our rivers and water systems as well as the micro plastics, essentially. And so even there, there are some developments, but it's more difficult to control because we don't produce those materials anymore. But I think it creates an opportunity for nonwovens because if you look at the total carbon footprint of a nonwoven versus a woven or knitted fabric, there's a very significant difference. And we can design these materials to be reusable, durable, launderable and produce less of a micro plastic type of pollution. And so I think people are beginning to take notice of that.

Virpi Rämö:

Yeah.

Behnam Pourdeyhimi:

And finding really an opportunity that hasn't existed yet and taking nonwovens and using them where they could also make a bigger difference.

Virpi Rämö:

Yeah. What about Ali, transformations coming up?

Ali Harlin:

Yeah. Clothing is obviously one of the big markets which are still untapped, if you wish to use such a strong word for it. So what will happen for sure is that when the developing countries are progressing on the road, their consumption habits will change. And there will be a huge, there are billions of people still who have not used nonwovens to anything. And they come to consumers. So in that way, we have to solve the recycling or waste management way or another. And I sincerely believe that it's a systemic issue. But like in that, we could see a total of new consumption materials made out of nonwoven which we are not already producing from other materials. Very, very difficult to see at the moment. Maybe the active materials might add something, but they are still replacing something which we have. But I see that there is the possibility to save more expensive material, more having a higher footprint of materials with using an affordable and sustainable nonwoven so that the replacement of the traditional material will continue at a greater and greater speed as we have seen in the past.

Virpi Rämö:

Great. Happy to hear that transformation is seeing to take place. So I have one final question for you guys, and this is sort of to bring hope for us all. So in an ideal future scenario, what do you see? How do you envision that nonwoven sector looks when it's as sustainable as possible? Any insights? What does that mean, a sustainable nonwoven sector? What does it bring into your minds?

Behnam Pourdeyhimi:

Well, I think, again, if I go back to what I stated earlier, the goals are to be zero carbon emission or be negative. And there are some companies that have already done that.

Virpi Rämö:

Yeah.

Behnam Pourdeyhimi:

So I think that's really critical. We use an awful lot of energy, even though our total carbon footprint is small compared to some of the other materials. But we still use a lot of energy because of melt processing and then using heat to dry materials and all of these things take a lot of energy. And so there are significant efforts in terms of reducing that dependence on energy. And part of that is really making what I call more functional, smarter machinery.

Virpi Rämö:

Yeah.

Behnam Pourdeyhimi:

So our industry is already moving towards really full automation is something that we've always had. But now we're moving towards going really far beyond automation.

Virpi Rämö: Yeah.

Behnam Pourdeyhimi:

And I call it creating autonomous machines where they make decisions to really, again, give you a better product, reduce waste, reduce energy. And it's already happening.

Virpi Rämö: Yeah.

Behnam Pourdeyhimi:

And so I think you're going to see a lot smarter machinery, a lot more complex machinery simply to deal with these challenges. And these machines will also perhaps be able to even help in processing new material. So we're becoming a lot smarter.

Virpi Rämö: Yeah. I like that.

Behnam Pourdeyhimi:

And so I think this would not be what I call my granddad's nonwoven industry that is going to be very different.

Virpi Rämö:

Yeah. Great. So zero emissions, smart manufacturing. Ali, anything to add to the list of bright futures in nonwovens.

Ali Harlin:

I sincerely believe that the question of CO2 in industrial processes, we start to have a good package of the solution, how to handle it. And actually, one of the sustainability problems is energy. We have a kind of energy crisis ongoing where we have zero emission energy available. But when you go beyond that, then we are digging deeper, deeper to the next stages. So it's the water, sweet water, particularly, and even coming more and more to the arable land, land usage. And to be sure that we can somehow stop the closing of the genome of the planet so that the biodiversity issues, they are really creeping up. And they are the next battle we are going to face. And obviously, we are going to find solutions for them as well. For the companies, how they look, I believe that they learn new things, they adapt new technologies, new machinery, all what is available when it's the right time. But they will be more integrated on a value chain. Everybody is standing on their own stone, but you have to take care where you get your material and what happens to it when it's done. So you have to integrate in that great cycle.

Virpi Rämö:

Yeah.

Behnam Pourdeyhimi:

I think one thing that's already also happening is some companies, in order to reduce their total carbon footprint...

Virpi Rämö:

Yeah.

Behnam Pourdeyhimi:

... and all of the things that we talked about and used less plastic. So the theme that I hear is not that we're going to get rid of plastics, but we want to use less plastics. And part of that is that they're setting goals to, for example, reduce the amount of nonwovens they use in the same products by as much as 50 percent.

Ali Harlin:

It's not only the energy and raw material, but it's water and all the possible. And it's not only the plastic, but it's all the ingredients you use. So use less. So two words is a very good way to head.

Virpi Rämö:

So energy efficient, zero emission, 50 percent less materials, integrated companies and actors, smart manufacturing. I like the sound of that kind of future. So going towards that, that's actually the end of our discussion today. So I thank you both for the eye-opening discussions and overview that we got and also inspiration for all of us and new ideas.

Behnam Pourdeyhimi:

Thank you.

Ali Harlin:

Thank you very much indeed.

Virpi Rämö:

So my name is Virpi Rämö and I hope that you enjoyed the podcast today and it helps you to understand the environmental challenges that we are tackling and the pathways to make sustainable transformation happen. We at Sustafit Research Project, funded by Business Finland, are researching nonwovens and bringing up pathways to a more sustainable future. Welcome to listen to all our other episodes too. We have several interesting guests coming up, both from academia and industry. And we open up the world of nonwovens together with these experts. See you soon again.

*Fiber futures.*

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