DISCOVER — ENGAGE — IMPACT

INDIGENOUS OPPORTUNITY SPROUTS FROM DESERT DISCOVERY

UQ nanotechnologists are working with remote Indigenous communities to process native spinifex grass into diverse commercial applications, from super-strong roads and tyres to super-thin condoms and surgical gloves.

In the searing heat on the outskirts of Camooweal in north-west Queensland, Colin Saltmere and his crew dig spinifex grass from the red dust.

The tough, spikey tussock grass dominates much of the red-sand desert and rocky ranges of Central Australia. It grows as far as the eye can see around Camooweal – a tiny town of just 315 people on the Queensland-Northern Territory border.

Mr Saltmere is the Director of the Dugalunji Aboriginal Corporation and proud Indjalandji-Dhidhanu man.

He has lived and worked on his people's traditional country in north-west Queensland his entire life and has overseen the establishment of Myuma Pty Ltd, an organisation that manages the ongoing development and expansion of Indigenous civil construction, hospitality, catering, labour hire and business training.

Indigenous Australians have collected spinifex for tens of thousands of years. Today, Mr Saltmere and his workers use shovels and hoes to harvest the grass. The methods may have changed, but the concept remains the same.

"Spinifex grass is an ancient and sacred material to Indigenous people, but also a material we use all the time," Mr Saltmere says.

"We've used it for building shelters, making beds, and as a glue in making instruments like spears and boomerangs. And we know that the oils and the waxes can be used to treat wounds and in other medicines.

"In Aboriginal culture, a product like that becomes a sacred thing. It belongs to country, and to us that's what 'sacred' means."

Indigenous knowledge of the grass and sustainable farming methods have caught the attention of western culture. And in these fields near Camooweal – among the red dust – this ancient craft is meeting cutting-edge science.

Working in partnership with the Indjalandji-Dhidhanu People, scientists from UQ's Australian Institute for Bioengineering and Nanotechnology (AIBN) have developed a method of extracting nanofibres from spinifex, which can then be used as an additive in latex products such as condoms and gloves.

The research – led by AIBN's Professor Darren Martin with Dr Nasim Amiralian and Dr Pratheep Annamalai – has found that the nanofibres from spinifex significantly improve the physical properties of latex, and can be used to make products such as condoms as thin as a human hair without any loss in strength.

"We can make a stronger and thinner membrane that is supple and flexible, which is the holy grail for natural rubber."

Professor Martin says the discovery is like nothing he has seen before.

"The nanofibres that we can extract are long, thin and stretchy – only a few nanometres wide but thousands of nanometres in length," he says.

"As a materials scientist, this is exactly what we look for when we want to reinforce flexible materials.

"We can make a stronger and thinner membrane that is supple and flexible, which is the holy grail for natural rubber.

"In 2015 we tested our latex formulation on a commercial dipping line in the United States and conducted a burst test that inflates condoms and measures the volume and pressure, and on average got a performance increase of 20 per cent in pressure and 40 per cent in volume, compared to the commercial latex control sample.

"Since then we have made excellent progress in the lab and with a little more refinement, we think we can engineer a latex condom that's about 30 per cent thinner, and will still pass all standards."

The AIBN began its research into spinifex in 2008, after UQ Anthropologist Professor Paul Memmott led a multidisciplinary research team, which included Professor Martin, to look at the science of spinifex, working with Indigenous communities to source the grass and investigate harvesting methods.

This led to a five-year funding grant from the Australian Research Council.

"That was the first foray into renewable materials for most of the AIBN team working on this project," Professor Martin says.

The research has also received funding from the Federal Government's Indigenous Advancement Strategy scheme, Myuma Pty Ltd, Dugalunji Aboriginal Corporation, Australian Research Council, the Queensland Government's Advance Queensland Research Fellowships scheme and UniQuest.

Dr Amiralian, now a Research Fellow with the AIBN, arrived at UQ from Iran in 2010 and began studying the sticky resins from spinifex as part of her PhD studies.

With a background in silk and other natural materials, her PhD project was designed around understanding the composition, extraction and purification of the resin.

"I did some research on applied things, such as using the resin as an anti-termite coating for timber, and found that it worked," she says.

"I found that the resin contains more than 100 different volatile and non-volatile components.

"We had a hunch that this was a highly evolved desert grass, but we didn't know just how different it was."

Under the guidance of Professor Martin, Dr Amiralian was able to discover unique nanofibres in spinifex grass.

"The first time I saw the nanofibres under the microscope, it looked completely different to anything I had seen before," Dr Amiralian says.

"Instead of short, stubby nanofibres, we ended up with ropey, flexible, long and thin nanofibres with a diameter of less than 10 nanometres (one-billionth of a metre).

"When added to rubber products, such as latex, the long, thin and ropey nanofibres help to retain the elasticity of the rubber, making it stronger while still very flexible and soft."

Professor Martin says the benefits of the nanofibre technology would interest latex manufacturers across the multi-billion-dollar global market, but could also revolutionise material science across multiple industries.

Work is under way to add spinifex nanofibres into other rubber compounds, plastics, and even carbon fibre. AIBN materials engineer Dr Annamalai is also researching the benefits of adding the nanofibres into bitumen to create more durable road surfaces.

"At St Lucia, we're changing the way people think about nanofibres, and our platform technology is starting to raise significant awareness about the differences between regular biomass and arid plants," Professor Martin says.

"If you look at the trends, most agriproducts have to be grown in more fertile areas. But those areas are being taken up very quickly.

"Sixty nine known species of spinifex grass are growing in Australia, mainly in parts of western Queensland, the Northern Territory and Western Australia. Making use of the arid parts of Australia to produce high-value nanotechnology products is very exciting.

"There is certainly an overwhelming amount of traditional knowledge involved in the management and use of spinifex, so we have to connect and work on this together."

Back in Camooweal, UQ and the Dugalunji Aboriginal Corporation have signed an agreement to recognise local Aboriginal traditional owners' knowledge about spinifex and to ensure that they will have ongoing equity and involvement in the commercialisation of the nanofibre technology.

"We're very excited by the prospects of commercialising the technology, but there's a bigger picture out there and that's remote Australia," Mr Saltmere says.

"This agreement with UQ will enhance the opportunity for employment in remote regions."

While mining and cattle farming provide some employment in north-west Queensland and parts of Western Australia, Mr Saltmere says remote Australia did not have a recognised industry to call its own.

"If you look at the demographic of local people in the labour market, there's not much work available. Spinifex farming can allow a natural process for creating employment," he says.

"You can naturally harvest the spinifex, which Aboriginal people have always done, bring it back to a central point and process it, then send it on for homogenisation to extract the nanofibres.

"There's potential to create industries from that product – like tyres, plastics and rubber – from a centralised location in central Australia.

"We've also envisaged using the region's Indigenous rangers as a managerial process for the environment where the spinifex grows. We want to provide full-time employment so that we're not drawing on government resources to employ rangers on country where the income from this industry could help these workers move into managerial roles.

"It's about providing jobs to our people and reclaiming some integrity."

AIBN Director Alan Rowan said while the discovery of spinifex nanofibres was exciting from a scientific and commercial perspective, the real benefits lie in the translation aspects behind the research.

"The AIBN effectively exists to do cutting-edge research for society. With this connection with Indigenous people, we have the opportunity to give even more back by turning science into employment," Professor Rowan says.

"There's a wonderful contrast. Here you see a process that has been undertaken by Aboriginal people for tens of thousands of years, and then suddenly we have nanotechnology, which has only been applied in the last five years.

"Now the two are connected and it tells us that we have so much more to learn by taking nature on board and examining it more closely."

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Highlights to date:

January 2008: Original ARC Discovery project *Towards Novel Biomimetic Building Materials: Evaluating Aboriginal and Western Scientific Knowledge of Spinifex Grasses* begins

March 2012: Gamage et al publish first research paper on the material engineering of spinifex resin and grass in *Australian Journal of Botany*

June 2012: PhD student Dr Nasim Amiralian makes first discovery of spinifex nanofibres at Australian Institute for Bioengineering and Nanotechnology (AIBN)

December 2014: UQ signs an umbrella research agreement with Dugalunji Aboriginal Corporation

January 2015: A second ARC Discovery Project on *High performance sustainable carbon fibres from Australian spinifex grass* allows research to expand in scope

May 2016: Intellectual property enters national phase of patent protection in USA, Japan, Europe and Australia

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