Professor Bronwyn Fox is CSIRO's Chief Scientist and she is powering ahead for science innovation and advancement. She spoke to Carole Goldsmith.

AMT: *Professor Bronwyn Fox. What is Quantum Technology?*

Prof. Bronwyn Fox: Quantum technology uses the building blocks of nature (subatomic particles) to improve our lives. Quantum Technologies will revolutionise the way we use sensing, computing and communications systems. These technologies will cut across a number of industry sectors including energy, secure communications, computer simulations and manufacturing.

It was evident from the conference that Australia has a vibrant research and start-up ecosystem, the result of over two decades of concentrated effort. It was wonderful to see Australian science being translated to create new companies, that are attracting investment and working with customers to solve complex problems.

Australia's Chief Scientist, Dr Cathy Foley, who was a key-note speaker at the conference today, has been working on Quantum Technology for many years. When Cathy was at CSIRO, she was leading a team that developed Superconducting Quantum Interference Devices (SQUIDs) which are used to measure minute changes in magnetic fields.

Cathy commercialised that technology over a decade ago and it's been used to discover more than $6bn in mineral deposits. Quantum technologies are being used in industry now. It's clear that the next stage of evolution will be the broader application of quantum technologies to solve the challenges we are facing globally around energy and the environment. That's what we've been discussing today.

AMT: *What are quantum sensors and how could they be used manufacturing?*

BF: Quantum sensors have unprecedented precision and a unique ability to detect very small changes, for example in magnetic fields. Industry is interested in how these sensors can be used to manufacture high precision medical imaging equipment, battery management systems for vehicles and precision timing to allow better machine to machine communication. This will improve the efficiency of automation and robotics in manufacturing.

AMT: *Your first job was at CSIRO, 30 years ago? What were you researching?*

BF: My first job after graduating from university was at the Cooperative Research Centre (CRC) for Polymers at the very beginning of the CRC program. I was one of the first employees at one of the first CRCs and I worked on a number of different projects simultaneously. The most significant one for me was recycling Polyethylene Terephthalate (PET), used to make drink bottles. We did a lot of work on understanding how to break down this polymer in a way that meant that it could be re-used.

AMT: *Tell me about your current job as CSIRO's Chief Scientist.*

BF: I started this role in October 2021. One of the things I'm most proud of, is our Impossible Without You program to recruit 200 early and mid-career researchers. We are committed to training the next generation of science leaders and thrilled to give this group opportunities for additional professional development and to come together as a cohort. I've known first-hand the power and potential of this program, when I joined CSIRO 30 years ago, as there was an influx of younger scientists and it led to a wonderful, vibrant, creative atmosphere.

We have called the recruitment campaign Impossible Without You because it is! We're saying that CSIRO is focused on solving Australia's and the world's greatest challenges and we can't do it without you, the best and the brightest.

We have also deliberately recruited for diversity in this cohort. To that, we've trained our recruitment panels on unconscious bias, on the power of diversity in delivering the type of innovation we need. True innovation is about creating completely new ways of working as well as products and solutions. We need new and diverse thinking, if we're going to do that. We've made sure we are mindful of every single facet of diversity and we've attracted some fantastic people. For me, it's really amazing to be part of CSIRO again and I really feel that connection to a sense of purpose that you have when you're here. It's an organisation where you feel like you are truly making a difference in solving challenging problems and creating new industries.

AMT: *What are these new industries?*

BF: In the past year, I've been to the launch of many different spinouts from CSIRO, one example is Chrysos Corporation.

The Adelaide-based Chrysos is a fascinating company. In partnership with CSIRO, they are using a CSIRO-developed photon assay to measure the concentration of gold in mineral deposits. In the past, that measurement took up to three weeks, now we can get that data almost instantly.

Traditional methods of measuring gold concentration also required high temperatures and the use of nasty analytical reagents. This was to check if the rock sample was viable, contained gold and really to answer the question of whether you should continue to be spending energy, time and money on it.

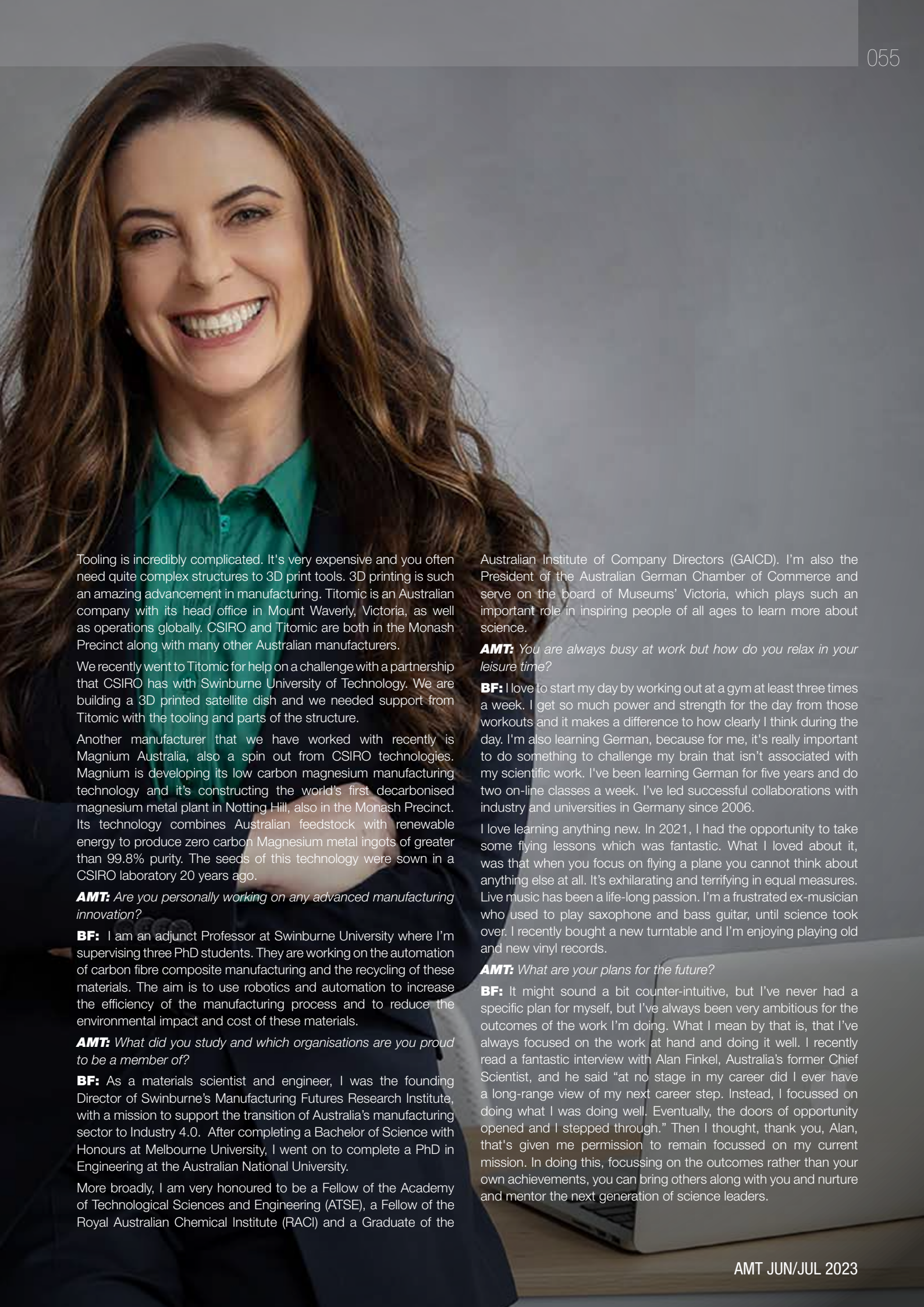
Where once that process took up to three weeks, the PhotonAssay allows for faster decision-making across the value chain. It uses powerful x-ray analysis and offers mineral analysis data in minutes. The technique uses high powered x-rays to bombard rock samples and activate atoms of gold and other metals. A highly sensitive detector then picks up the unique atomic signatures from these elements to determine their concentrations.

Chrysos was listed on the Australian Stock Exchange (ASX) in May 2022. CSIRO's Chief Executive, Larry Marshall was there to ring the ASX bell and CSIRO remains Chrysos' largest shareholder.

There's also another benefit. By using the photon assay instead of the traditional method of measuring gold concentration, Chrysos has reduced CO2 emissions by 2600.9 tonnes and cut 1752.8 tonnes of hazardous waste materials from the gold mining companies that it works with.

AMT: *Can you tell us about two manufacturers that you have done projects with?*

BF: We've worked extensively with Titomic, an additive manufacturing company that uses cold spray technology, software and robotics in its automated metals manufacturing. The fundamentals of cold spray technology were developed at CSIRO, many years ago. We are currently working with Titomic creating 3D tools for manufacturing, as the company has one of the largest 3D printers in the Southern Hemisphere.



Tooling is incredibly complicated. It's very expensive and you often need quite complex structures to 3D print tools. 3D printing is such an amazing advancement in manufacturing. Titomic is an Australian company with its head office in Mount Waverly, Victoria, as well as operations globally. CSIRO and Titomic are both in the Monash Precinct along with many other Australian manufacturers.

We recently went to Titomic for help on a challenge with a partnership that CSIRO has with Swinburne University of Technology. We are building a 3D printed satellite dish and we needed support from Titomic with the tooling and parts of the structure.

Another manufacturer that we have worked with recently is Magnium Australia, also a spin out from CSIRO technologies. Magnium is developing its low carbon magnesium manufacturing technology and it's constructing the world's first decarbonised magnesium metal plant in Notting Hill, also in the Monash Precinct. Its technology combines Australian feedstock with renewable energy to produce zero carbon Magnesium metal ingots of greater than 99.8% purity. The seeds of this technology were sown in a CSIRO laboratory 20 years ago.

AMT: *Are you personally working on any advanced manufacturing innovation?*

BF: I am an adjunct Professor at Swinburne University where I'm supervising three PhD students. They are working on the automation of carbon fibre composite manufacturing and the recycling of these materials. The aim is to use robotics and automation to increase the efficiency of the manufacturing process and to reduce the environmental impact and cost of these materials.

AMT: *What did you study and which organisations are you proud to be a member of?*

BF: As a materials scientist and engineer, I was the founding Director of Swinburne's Manufacturing Futures Research Institute, with a mission to support the transition of Australia's manufacturing sector to Industry 4.0. After completing a Bachelor of Science with Honours at Melbourne University, I went on to complete a PhD in Engineering at the Australian National University.

More broadly, I am very honoured to be a Fellow of the Academy of Technological Sciences and Engineering (ATSE), a Fellow of the Royal Australian Chemical Institute (RACI) and a Graduate of the Australian Institute of Company Directors (GAICD). I'm also the President of the Australian German Chamber of Commerce and serve on the board of Museums' Victoria, which plays such an important role in inspiring people of all ages to learn more about science.

AMT: *You are always busy at work but how do you relax in your leisure time?*

BF: I love to start my day by working out at a gym at least three times a week. I get so much power and strength for the day from those workouts and it makes a difference to how clearly I think during the day. I'm also learning German, because for me, it's really important to do something to challenge my brain that isn't associated with my scientific work. I've been learning German for five years and do two on-line classes a week. I've led successful collaborations with industry and universities in Germany since 2006.

I love learning anything new. In 2021, I had the opportunity to take some flying lessons which was fantastic. What I loved about it, was that when you focus on flying a plane you cannot think about anything else at all. It's exhilarating and terrifying in equal measures. Live music has been a life-long passion. I'm a frustrated ex-musician who used to play saxophone and bass guitar, until science took over. I recently bought a new turntable and I'm enjoying playing old and new vinyl records.

AMT: *What are your plans for the future?*

BF: It might sound a bit counter-intuitive, but I've never had a specific plan for myself, but I've always been very ambitious for the outcomes of the work I'm doing. What I mean by that is, that I've always focused on the work at hand and doing it well. I recently read a fantastic interview with Alan Finkel, Australia's former Chief Scientist, and he said "at no stage in my career did I ever have a long-range view of my next career step. Instead, I focussed on doing what I was doing well. Eventually, the doors of opportunity opened and I stepped through." Then I thought, thank you, Alan, that's given me permission to remain focussed on my current mission. In doing this, focussing on the outcomes rather than your own achievements, you can bring others along with you and nurture and mentor the next generation of science leaders.