

Physical Sciences Innovation Pipeline | April 2021

Program name	Description	TRL 1 - 3	TRL 4 - 5	TRL 6 - 7	TRL 8 - 9
Formulation technologies					
Pesticide formulation technology	Silica carrier particles that encapsulate active ingredients (AI) to provide UV protection, increased rainfastness and easier formulation of hydrophobic AI	●	●		
Engineered nano-clay for agriculture applications	Novel nano-clay technology with enhanced cation exchange capacity and efficient loading of agricultural actives	●	●		
Nanocapsules	Encapsulated emulsion droplets for sustained or burst release of active ingredients, including microbes	●	●		
Advanced adjuvants for vaccine applications	Surface modification of silica-based nanoadjuvants provokes enhanced cell mediated innate immunity, cellular and humoral immune responses	●			
UAVs and robotics					
Y4	A more efficient quadrotor UAV design with longer duration suitable for industrial applications	●	●	●	
Safety rotor	A lightweight safety feature for minimising blade impact in UAV operation	●	●	●	
Bipedal robot	A low cost gyroscopically stabilised bipedal robot	●			
Sensors, devices and optoelectronics					
Compact load cell	Novel method of detecting force and torque for various applications including UAV, robotics and sports	●	●	●	
Quantum technology for terahertz imaging and sensing	High-performance terahertz laser feedback interferometric imaging and sensing	●	●		
Ultra high sensitivity magnetometer	Ultrasensitive chip-sized detection of magnetic fields at room temperatures	●			
Passive on-chip microwave circulator	A passive, on chip, superconducting microwave circulator with high bandwidth (~500 MHz), for use in mobile communications and quantum computing	●			
Light emitting field effect transistors	An organic light-emitting field-effect transistor containing a delayed fluorescent material, excitons can be efficiently used for light emission to remarkably enhance the emission efficiency of the transistor and high mobility along with high on/off ratios	●			
Organic lasing materials	Electrically pumped organic semiconductor lasers based upon novel optical cavities and organic semiconductors. Applications in flexible, flat screen displays, sensors, spectroscopy and telecommunications	●			
Microwave inspection system	Microwave inspection technology with automated scanning for multiple surfaces	●			
Quantum dots (QD) for display applications	Process for synthesising highly stable QDs with efficient light emission demonstrated in deep red and near infrared (process can also be applied to green and blue QDs)	●			
Nano-phononic circuit platform	Nano-mechanical computation and sensing platform that is robust to radiation	●			
Perovskite composite material	New class of composite material which enhances the optical properties and stability of perovskites	●			
Big data solutions and analytics					
Advanced mobility analytics	Video analytics technology which focuses on changing the paradigm of current traffic safety management practice by proactively identifying and diagnosing safety issues before they occur using artificial intelligence (AI) and advanced econometrics. Packaged as SaaS	●	●	●	
Automated Topology Builder (ATB)	Accurate force field parameters for molecular modelling and molecular dynamics	●	●	●	
Orthogonal precoding for sidelobe spectrum suppression	A novel method for increased spectral efficiency in communication systems. Out of band power suppression using blocking reflectors in the allocated spectrum for enhanced gain	●	●		
Water and environmental					
Sewex	Algorithm-based software for H2S, corrosion reduction and sewer network modelling. Potential for SaaS redevelopment. Commercial projects Australia-wide and globally	●	●	●	●
Lodomat	An advanced system for wastewater treatment of sludge utilising anaerobic digestion, free nitrous acid (FNA) to inactivate nitrite oxidising bacteria (NOB), partial nitrification using NOB to remove nitrogen followed by Anammox process and altering ammonium to alkalinity ratio	●	●		
Alkaline digestion of waste glass	A simple process developed for the extraction of sodium silicate from soda-lime glass, characterised by a high utilisation of the raw material and energy embodied in glass	●	●		
PFAS	Innovative technologies to investigate and remediate PFAS (per- and poly-fluoroalkyl substances) contaminated media including soil and other solid contaminated debris, groundwater, waterways and marine	●			
Gold recovery from e-waste	Recovering gold and other metals from e-waste using low capex/opex hydrometallurgical process	●			
Dewatering process for wastewater sludge	Use of pulsed power and ultrasound for dewatering wastewater organic sludge	●			

Technology Readiness Levels (TRLs)

- TRL 1** Basic principles observed
- TRL 2** Technology concept formulated
- TRL 3** Experimental proof-of concept
- TRL 4** Technology validated in lab
- TRL 5** Technology validated in relevant environment
- TRL 6** Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 7** System prototype demonstration in operational environment
- TRL 8** System complete and qualified
- TRL 9** Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

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Advanced materials					
Nanocomposite elastomers	Strong, tough, yet low modulus elastomers enabled by reinforcement with flexible, tough nanofibers of cellulose	●	●	●	
Nanocellulose	High aspect ratio, extremely tough nanofibers of cellulose for reinforcement, paper, concrete and other applications	●	●	●	
<u>Ultra-bright, low power QD displays and lighting</u>	Significantly improve the ability of quantum dots (QDs) to capture incident light and produce a brighter fluorescence emission	●	●		
<u>Efficient production of cyclic proteins</u>	Protocol for synthesising circularised proteins that is low-cost and high-yield	●	●		
Graphene processing strategy for improved battery cathodes	Processed graphene as cathode in Aluminium-ion battery shows high specific discharge capacity and excellent reversibility	●	●		
PHA biopolymer composites	Biodegradable PHA bioplastics, biocomposites and bio-products	●	●		
Alloys for 3D printing	High strength and high ductility Ti and Cu alloys with inexpensive nanoparticles using innovative chemistry	●			
Carbon matrix composites	A composite material which can be used as a fire resistant or fire retardant polymer. When pyrolyzed, the material produces a high strength of carbon-carbon composite for use in high temperature applications such as brake components for Formula 1 cars, nose cones and flight surfaces of supersonic and hypersonic vehicles and heat exchangers	●			
<u>Carbon fibre conversion from PVC</u>	Method for forming higher strength/lower weight carbon fibre from contaminated waste and virgin polyvinylchloride (PVC)	●			
Mining and energy innovation					
Producing zeolite from mining tailings	A novel technology to use waste and mining tailings to produce high value zeolite	●	●		
Borehole condition monitoring sensor	Low-cost, disposable sensor probe for automatic depth detection in boreholes to improve outcomes in drill and blast operations	●	●		
Solid oxide fuel/electrolysis cells	A solid oxide fuel cell designed with enhanced thermal management providing enhanced longevity	●	●		
Frother measuring system	An <i>in-situ</i> device to accurately measure frother concentration in a flotation cell to increase efficiency, yield and revenue of a mining process	●	●		
Froth deaeration system	A deaerator apparatus that has been demonstrated to achieve significant air reduction of coal froth	●	●		
<u>Record efficiency quantum dot (QD) solar cell</u>	Breakthrough on low-cost emerging generation QD solar cells that achieve a verified world record efficiency of 16.6%	●	●		
<u>Solar F2D2 - solar farm fault detection & diagnosis</u>	An algorithmic system that has automatic fault detection, performance monitoring and predictive modelling for solar farm photovoltaic (PV) panels	●	●		
<u>Flotation stability improvement system</u>	An <i>in-situ</i> device to improve stability of froth in the mineral flotation process, using specific sound waves	●			
<u>High voltage pulse power separation system</u>	Integrated separator system and process for preconcentration of materials using high voltage pulse power	●			
<u>Dewatering process for mining tailings</u>	High frequency/low voltage pulse power dewatering process for mining tailings such as copper, coal and red mud	●			
Enzymatic metal processing	Processing of low grade ore to recover valuable metals using an enzyme-driven bioleaching step	●			
<u>Supercritical CO2 turbine</u>	Highly efficient small-scale (up to 30 MW) powerblock for integration with a wide range of distributed energy generation technology and also waste process heat recovery	●			
Removal of uranium from copper concentrates	Efficient process for the removal of radionuclides and other contaminants from copper concentrates	●			
<u>Bayer process improvement</u>	Cost reduction for alumina production through reduced caustic soda consumption	●			
<u>Improved off-the-road wheels</u>	Safer wheels for pneumatic tyres for off-road earth moving and mining vehicles	●			
Manufacturing technologies					
Fire retardant glulam timber beams	Manufacturing-friendly process for fabricating low depth, glulam timber beams with FRP for improved fire performance at comparable costs	●	●		
Medical technologies					
Ultra-low field MRI	Low magnetic field strength enables the instrument to be used at the bedside, unlike conventional MRI scanners	●	●		
<u>Psychomotor Vigilance Task (PVT) test alternative</u>	A novel method for assessing neuropsychological impairment using electroencephalogram (EEG)	●	●		
<u>Sleep apnea assessment</u>	At-home screening and/or diagnosis of sleep apnea using snore sounds captured on a mobile phone	●	●		
High sensitivity immunoassays	Nanotechnology-enabled amplification of signals in immunoassay to lower limits of detection	●	●		
RF coil-element for UHF MRI	RF coil-element designed to have low sensitivity to loading changes, superior inter-element isolation, and better efficiency regarding RF energy deposition	●	●		
AI platform for early skin cancer diagnosis	A smart-device based application which utilises mathematics and Artificial Intelligence (AI) to automate patient skin self-examination	●			