JOINT NEWS RELEASE

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NTU Singapore and Se-cure Waste Management build pilot recycling plant to tackle lithium-ion battery waste with biomass waste

Following a successful proof-of-concept to recycle spent lithium-ion batteries using reagent extracted from fruit peel waste, **Nanyang Technological University, Singapore (NTU Singapore)** is partnering **Se-cure Waste Management Pte Ltd (SWM)**, a Singapore battery recycling and processing company, to scale up the technology in a pilot plant.

The pilot battery recycling plant has the capacity to process up to 2,000 litres of spent shredded battery mixed with fruit peel derived solvents for extraction of electrode materials such as cobalt, lithium, nickel, and manganese.

The scientists from the **NTU Singapore-CEA Alliance for Research in Circular Economy (SCARCE)**, who developed the technology of using fruit peel waste to tackle battery waste, is also looking at using other types of biomass waste.

A key feature of the pilot plant is its modular design, which allows it to be easily configured for optimal reaction conditions to extract different types of metal.

Currently, less than 5 per cent of spent lithium-ion batteries are recycled globally and the volume of these spent batteries is projected to reach 11 million tonnes by 2030. Such technology could meet the urgent need for a recycling solution that is environmentally benign and can be easily scaled up, said the scientists from SCARCE.

Located at Neythal Road off Pioneer Road North, the pilot plant has been operational since the last quarter of 2022. Over the course of this year, the NTU and SWM team will work to optimise processes that maximise the extraction yield of valuable metals from battery waste for reuse at pre-commercial scale.

They will also evaluate the plant's technical performance and economic viability with the goal of commercialising the technology.

Associate Professor Dalton Tay from the **NTU School of Materials Science and Engineering** and **Cluster Director of the Energy Research Institute @ NTU (ERIAN)** said: “With the proliferation of mobility devices and portable electronics, the model of extracting raw materials from the earth, using them, then discarding them is clearly unsustainable. Instead of relying on conventional mining of resources, we need to look at recovering and reusing the precious metals from our electronic waste. This integrated lithium-ion battery recycling pilot plant serves as an important engineering platform that takes us one step closer. Thanks to the support of NTUitive, NTU’s innovation and enterprise arm, we are able to work with SWM to take our technology from lab to industry, bridging the gap in the innovation continuum and paving the way towards its commercialisation.

“The use of biowastes such as fruit peel discards to close the loop on lithium-ion batteries is also a unique value proposition for potential carbon offsetting and creation of new distribution networks for green commodities. This homegrown effort enables us to make great strides towards a new and green circular economy in tackling bio- and electronic waste.”

Mr Vince Goh, Managing Director, Se-cure Waste Management, said: “Our collaboration with Assoc Prof Tay and the setting up of the pilot plant allow the seed of local innovation to grow and eventually flourish. This also provides SWM a closed-loop solution beyond processing batteries while enabling a greener and cleaner recycling process for resource sustainability. SWM and NTU will evaluate the commercial feasibility of NTU’s technology at a meaningful scale. In combination with our upstream core expertise in robotics-enabled electronic vehicle battery discharging and dismantling, as well as battery processing, SWM offers a systematic management of e-waste for the entire cradle-to-cradle process.”

Professor Madhavi Srinivasan, Executive Director, NTU Sustainability Office, and SCARCE Co-Director, said: “This collaboration between NTU and SWM is part of NTU’s commitment to build a sustainable tomorrow, and fosters outcomes that address industry and societal needs outlined in **NTU2025**, the University’s five-year strategic plan. It is also in line with Singapore’s Zero Waste Masterplan, which charts the strategies towards a sustainable, resource-efficient, and climate-resilient nation.”

The fruit peel technology to recycle battery waste developed by SCARCE is supported by Singapore’s National Research Foundation and the National Environment Agency (NEA) under the Closing the Waste Loop Funding Initiative (Award No. USS-IF-2018-4).

Such efforts are also aligned with NEA’s Environmental Services Industry Transformation Map (ES ITM) 2025 in harnessing opportunities in environmental

sustainability, and to pre-position companies like SWM for emerging opportunities in growth areas such as electronic vehicle batteries recycling.

Using biomass waste to replace strong chemicals

In 2020, an NTU team led by **Associate Professor Dalton Tay** and **Professor Madhavi Srinivasan** successfully extracted over 90 per cent (in weight) of the precious metals found in processed lithium-ion battery waste in the lab using orange peel waste and made new batteries with these recovered metals.

This method of using fruit peel waste in place of conventional strong chemicals and acids to extract precious metals from battery waste is called **hydro-organic-metallurgy**.

The scientists have since successfully replicated their success in the lab using other types of fruit peel waste – such as the peel of pineapples, pears, and lemons – before working with local e-waste recycling company Se-cure Waste Management (SWM) to scale up this technology. The scientists are now looking into the possibility of using other types of biomass waste.

In this new pilot plant, the process starts with SWM shredding and crushing spent lithium-ion batteries to form a crushed material, from which plastics and metals like copper, aluminium, and iron are separated. On average, the company processes 18 tonnes of spent lithium-ion batteries every day.

The final product, called black mass, contains the precious metals – cobalt, lithium, nickel, and manganese – to be extracted for reuse.

Black mass is poured into the pilot plant and dissolved in chemical concoctions derived from fruit peel wastes that has been oven-dried and ground into powder. These concoctions, which the scientists have filed a patent for, are designed to leach out precious metals over low heat.

Fruit peel is rich in sugars, naturally occurring antioxidants such as flavonoids and phenolic acids, and organic acids – all of which will enhance the dissolution and recovery of metals from the battery waste.

The precious metals are then precipitated into metal salts that can then be used to assemble new lithium-ion batteries.

Earlier, the NTU scientists demonstrated that lithium-ion batteries made from recovered metals showed similar charge capacity to commercial ones.

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About Nanyang Technological University, Singapore

A research-intensive public university, Nanyang Technological University, Singapore (NTU Singapore) has 33,000 undergraduate and postgraduate students in the Engineering, Business, Science, Medicine, Humanities, Arts, & Social Sciences, and Graduate colleges.

NTU is also home to world-renowned autonomous institutes – the National Institute of Education, S Rajaratnam School of International Studies, Earth Observatory of Singapore, and Singapore Centre for Environmental Life Sciences Engineering – and various leading research centres such as the Nanyang Environment & Water Research Institute (NEWRI) and Energy Research Institute @ NTU (ERI@N).

Under the NTU Smart Campus vision, the University harnesses the power of digital technology and tech-enabled solutions to support better learning and living experiences, the discovery of new knowledge, and the sustainability of resources.

Ranked amongst the world's top universities, the University's main campus is also frequently listed among the world's most beautiful. Known for its sustainability, over 95% of its building projects are certified Green Mark Platinum. Apart from its main campus, NTU also has a medical campus in Novena, Singapore's healthcare district.

For more information, visit www.ntu.edu.sg

About Se-cure Waste Management Pte. Ltd. (SWM)

Se-cure Waste Management Pte. Ltd. (SWM) is a Singapore based organization specializing in the recycling, recovering and/ or repurposing of electronic scrap and waste (known as e-waste) with the use of innovative technology to yield the highest

possible recycling rate with minimal environmental impact, contributing to resources sustainability.

Founded in 2019 with a focus in lithium-ion batteries and with a vision to “create and secure a greener environment for our future generations”, SWM is strategically set to be an integrated e-waste solutions provider for resource re-cycling, re-covering, and re-purposing, creating sustainable resources for our environment. Without a proper evaluation of secondary use possibilities or proper disposal solutions, lithium-ion batteries will contribute to environmental pollution and adverse human health impact due to its potentially hazardous materials contained. The precious metals within these lithium-ion batteries would be permanently disposed when they could have been up-cycled for new/ secondary uses. SWM is one of the few local enterprises to handle the recycling of e-waste into a form which is readily transformed into new raw materials through a mechanical transformation process.

Poised to lead the forefront for battery recycling innovation, SWM aims to offer to its diverse stakeholders environmentally friendly e-waste management solutions that meet the unique needs of businesses and at the same time, being responsible in creating a sustainable future as the world faces unprecedented environmental challenges and the realization of these collective goals. Waste today, precious resources tomorrow.

www.se-curewaste.com