From waste to energy: Rice husks and Li-ion batteries

Silicon (Si) is considered a promising candidate for anode material for the next generation of Li-ion batteries due to its high theoretical capacity of approximately 4200 mAh/g, which is ten times higher than that of commercial graphite anodes (372 mAh/g). However, Si has major drawbacks stemming from large volume expansion (up to 300%) experienced during lithiation. The lithiation-induced mechanical stresses cause Si structures to fracture when the characteristic dimension is as small as 150 nm, which promotes pulverization and loss of active material. Despite scaling the dimensions of Si architectures below this critical dimension, the large volume expansion deteriorates the integrity of the solid electrolyte interphase (SEI). Expansion upon lithiation and subsequent contraction during delithiation leads to the contact fracturing and reformation of new SEI, resulting in irreversible capacity loss. Several anode nanostructures such as double-walled Si nanotubes, porous Si nanowires, and heat-treated Si nanoparticles have alleviated this issue by protecting the crucial SEI layer after initial formation. Other strategies include alloying with inactive elements and embedding active Si particles in a matrix of conductive carbon or metal oxides.

A team at the Illinois Sustainable Technology Center, led by Junhua Jiang, along with scientists from Argonne National Laboratory has successfully produced multi-component Si-based materials from rice husk, an abundant agricultural process residue, and demonstrated their potential as Li-ion anode materials. Rice husks are comprised of 20 wt% silica and 80 wt% organic matter. Based on the annual global rice husks output of 1.2×10^8 tons per year, the capacity for Si production is 11 million tons per year. This exceeds the total current output of approximately 7 million tons for bulk Si. Therefore, rice husk-derived Si has the critical advantage of scalability for large-scale applications such as electric vehicles.

What should be done with the 80% left over organic matter from the rice husks? Jiang suggests that the rice husks could be make into **biochar** and used in supercapacitors but further research is needed.

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