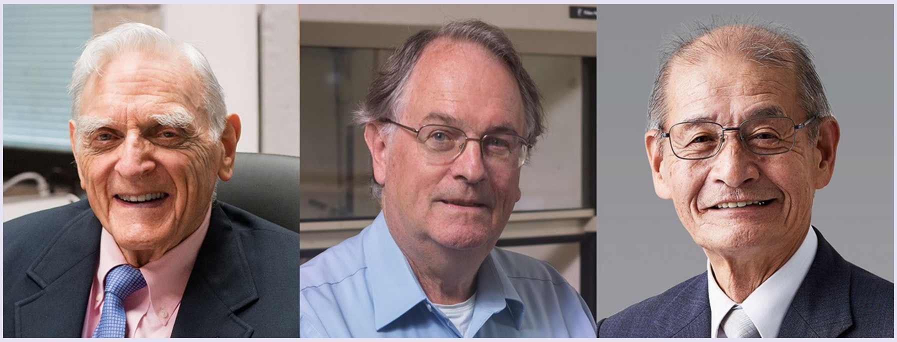
2019 NOBEL PRIZE IN CHEMISTRY

The Li-ions share



Credit: Left, Cockrell School of Engineering, The University of Texas at Austin; middle, Binghamton University, State University of New York; right, Japan Prize Foundation

For the past decade or so, when October has rolled around and chemists have begun to feverishly chatter about the next recipients of the Nobel Prize, the same topic and the same three researchers have been mentioned in almost every conversation. Next year, chemists will need to find a new favourite prediction, because the Nobel Prize in Chemistry has now — finally — been awarded for the development of lithium-ion batteries to John Goodenough from the University of Texas at Austin, Stanley Whittingham from Binghamton University and Akira Yoshino from Meijo University.

It is not hyperbolic to say that the rechargeable lithium-ion battery has changed the world. It enabled the portable-technology revolution, powering the electronics that we use to work, study, communicate and play. Its development began in the 1970s when Stanley Whittingham (pictured, centre), who was then working for the oil company Exxon, developed the prototype. The rechargeable batteries that had been developed up until that point had some serious drawbacks; they were heavy, contained toxic metals and suffered from capacity loss. Lightweight lithium, with its favourable redox potential, was thought to be a promising battery material, but its reactivity needed to be tamed. The first issue was to find materials that could be paired with a lithium metal anode and Whittingham did just that — discovering that lithium ions could intercalate into titanium disulfide, which could thus function as a battery cathode.

The next leap came when John Goodenough (pictured, left), then at the University of Oxford, took up the challenge of improving the cathode material. Reasoning that metal oxides would have electrochemical-potential benefits over sulfides, Goodenough swapped out the titanium disulfide for cobalt oxide, generating a 4 V battery that was almost twice as powerful. Goodenough's improved cathode enabled anode materials with higher potentials than lithium metal to be used. And this is where Akira Yoshino (pictured, right), who was working at the Asahi Kasei Corporation, stepped in. He replaced the lithium metal anode with 'petroleum coke', a carbon material that can also intercalate lithium ions. This resulted in what is known as a 'rocking-chair' battery — which uses an intercalation compound for both electrodes — that was safer and more stable, and was suitable for commercial use. ❐

Gavin Armstrong

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BIOCATALYSIS

Identifying an iodinase

Flavin-dependent halogenases catalyse the regioselective formation of carbon–chlorine and carbon–bromine bonds using oxygen and inorganic halide salts. Now, genome mining has led to the discovery of a previously unknown viral halogenase that catalyses the iodination of arenes, thereby providing a rare biocatalytic tool for the formation of carbon–iodine bonds.

Christian Schnepel and Nicholas J. Turner

Halogenation represents one of the most important transformations for C–H activation currently used in synthetic organic chemistry. Haloarenes — typically made by electrophilic halogenation of an aromatic ring — are widely used as substrates in metal-catalysed cross-coupling reactions (for example, Suzuki–Miyaura, Mizoroki–Heck, Buchwald–Hartwig amination) to create libraries of compounds for screening. The presence of a halogen atom can also impact the pharmacological properties of bioactive compounds. However, chemical introduction of halogens often requires hazardous procedures and