Freeing the bonds: 2010 Nobel highlights the carbon future

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In the 1960s, American scientists made an exciting discovery: a compound extracted from the bark of the Pacific yew tree destroyed cancer cells in the lab.

Tested on mice and then later on humans, the chemical, known as taxol, was touted as a potential wonder cure for breast and ovarian cancer... and then its troubles began.

The annual dose of taxol for just one person required six yews to be chopped down. Each year, it was realised, hundreds of thousands of these slow-growing trees would have to be cut to meet demand from cancer patients in America alone.

As the sustainability problem became clear, taxol became one of the rarest and most expensive drugs on the market. The alarm sounded: Without a man-made alternative, many people would die.

More than 30 groups plunged into a race to synthesise the complex molecule, and the outcome eventually was a drug now produced in industrial quantities and a standard weapon to attack cancer.

Underpinning that exploit, though, was a toolkit enabled by three men whose work earned them the 2010 Nobel Prize for Chemistry.

The laureates are Richard Heck of the United States and Ei-ichi Negishi and Akira Suzuki of Japan, honoured for palladium-catalysed cross

coupling, a cornerstone in organic, or carbon, chemistry.

Carbon is arguably the most essential atom of all, providing the skeletal core of molecules for life and innumerable synthetics.

Rearranging the bonds between these atoms lies at the heart of creating new compounds. It is achieved through a chemical reaction that alters the electron cloud encircling the carbon atom. Destabilised, the atom seeks another atom with which to bond.

Previously, chemists had to kickstart this process by using powerful reactive substances. This did the job of creating the carbon-carbon bond, but often at the cost of creating unwanted by products.

Palladium-catalysed cross coupling, though, is a milder, slicker and more precise way of carrying out the reaction.

The element palladium is used as a lure for carbon atoms. They attach to the palladium atoms, clustering close enough for the bonding reaction to start, but without consuming the palladium, which is freed up after the process and can be used again.

The tool has been essential in the quest for new medicines, based on ever-more complex molecules found in some surprising or exotic niches of nature.

They include diazonamide A, a prototype drug found to be effective against colon cancer, that was synthesised from a Philippine sea squirt; and dragmacidin F, derived from a sponge living off the coast of Italy, which in lab tests combats the herpes virus and HIV.

Palladium-catalysed cross coupling can also be used to modify antibiotics, such as vancomycin, a drug that is being tweaked to combat

hospital superbugs.

The process is also important in plastics, where the compound styrene is the major ingredient in polystyrene, and in the electronics industry, for example to help find better light sources for diodes, resulting in monitors that are just a few millimetres thick.

Agribusiness, too, uses the process. Using the element boron rather than palladium as the catalyst, the reaction helps make a chemical to protect crops from fungus.

"The discoveries of Richard Heck, Ei-ichi Negishi and Akira Suzuki are already of great importance to humanity," the Nobel committee said.

"However, taking into account the developments currently being made in laboratories worldwide, their reactions are likely to become even more important in the future."