as well as being used in fuel cells. But, he said, platinum's high cost and limited availability have made its use in clean energy technologies largely impractical— until now.

"There's a lot more cobalt out there than platinum," said lead author and Johns Hopkins post-doctoral fellow Lei Wang (not related to Chao Wang). "We've been able to significantly stretch the benefits of platinum by coating it over cobalt, and we even managed to enhance the activity of platinum at the same time."

Earlier attempts to plate precious metals on non-precious materials were largely stymied by galvanic replacement reactions—oxidation of the non-precious metal. In this study, the team successfully suppressed such reactions by introducing carbon monoxide, a gas molecule that strongly binds to cobalt, protecting it from oxidation.

Not only did the cobalt-platinum nanoparticles reduce the usage of platinum; they performed almost 10 times better than platinum alone. The researchers said this enhanced catalytic activity resulted from both the maximized exposure of platinum atoms on the surface and from interactions between the two metals. "The intimate contact between cobalt and platinum gives rise to compressive strain," Lei Wang said. "It shortens the distance between platinum atoms and makes the chemical reactions more feasible on the surface."

Because platinum and other rare metals play key roles in many industrial applications, the implications of this work extend beyond fuel cells. Currently, the team is working on adapting their technique to other precious metals and non-precious substrates. New developments will target further applications of such materials in chemical conversions of hydrocarbons.

"Many reactions that depends on precious metal catalysts could be rendered cheaper and more effective by taking advantage of our technology," Chao Wang said. "At a time when we are becoming painfully aware of the limits of our non-renewable sources of energy and materials, this technique points us in a very welcome new direction."

Single Atom Memory: The World's Smallest Storage Medium

One bit of digital information can now be successfully stored in an individual atom, according to a study just published in *Nature*. Current commercially-available magnetic memory devices require approximately one million atoms to do the same. Andreas Heinrich, newly appointed Director of the Center for Quantum Nanoscience, within the Institute of Basic Science (IBS, South Korea), led the research effort that made this discovery at IBM Almaden Research Center (USA). This result is a breakthrough in the miniaturisation of storage media and has the potential to serve as a basis for quantum computing.

Disks coated with a magnetised layer of metal allow our computers to store files in the form of bits, each with the value of either 1 or 0. A certain direction of magnetisation corresponds to the 0 bit, the other direction to the 1 bit. While at the moment small areas of the disk, of around a million atom, correspond to each digital bit of information, this research went way beyond this and utilised the smallest amount of matter usable for this purpose: one atom.

In this study, scientists worked with a tool, called Scanning Tunneling Microscope (STM), which has a special tip that enables the user to view and move individual atoms, as well as to apply a pulse of electrical current to them. They used this electric pulse to change the direction of magnetisation of individual holmium atoms. By doing that, the team could write a memory of either 1 or 0 in a single holmium atom as well as swap the two.

A quantum sensor, designed by Heinrich's team and currently unique worldwide, was used to read the memory stored in the holmium atom. It consists of an iron atom placed next to the holmium atom. Using this technique, as well as another one, called tunnel magnetoresistance, the researchers could observe that holmium maintains the same magnetic state stably over several hours.

Then, when Heinrich's team of researchers tried to use two holmium atoms instead of one, they made another surprising discovery. Placing holmium atoms even one nanometer apart did not impact their ability to store information individually. This came as a surprise, since it was expected that the magnetic field from one atom would impact its neighbour. To put this scale into perspective, if a nanometer were blown up to the diameter of a typical human hair, the hair would have a diameter equivalent to the length of a school bus in comparison.

In this way, the scientists could build a two bit device with four possible types of memory: 1-1, 0-0, 1-0 and 0-1 clearly distinguished by the iron sensor.

Moore's Law predicted that the amount of data that can be stored on a microchip would double every 18 months and indeed this happened for decades. The last model electronic devices are always smaller and more powerful than the previous one. However, as devices become smaller and smaller, since atoms are so close to each other, new interfering quantum properties begin to manifest and cause problems. The impossibility of keeping up with further miniaturisation, brought experts to talk about the death of Moore's Law.

Interestingly, holmium atoms seem to escape this fate, for still unknown reasons. "There are no quantum mechanical effects between atoms of holmium. Now we want to know why," points out Heinrich. Holmium atoms can be arranged very closely together, so the storage density using this single-atom technique could be very high. He continues: "We have opened up new possibilities for quantum nanoscience by controlling individual atoms precisely as we want. This research may spur innovation in commercial storage media that will expand the possibilities of miniaturising data storage."

Heinrich is one of the few in the world using this tool to measure and change the properties of individual atoms. He plans to significantly expand on this research at his newly created IBS research centre, located at Ewha Womans University in Seoul.

Stress May Protect, at Least in Bacteria

Antibiotics harm bacteria and stress them. Trimethoprim (TMP), an antibiotic, inhibits the growth of the bacterium Escherichia coli and induces a stress response. This response also protects the bacterium from subsequent deadly damage from acid. Antibiotics can therefore increase the survival chances of bacteria under certain conditions. This is shown in a study by researchers at the Institute of Science and Technology Austria (IST Austria), carried out by Karin Mitosch, Georg Rieckh and Tobias Bollenbach, which was published in the journal *Cell Systems.*

Bacteria often encounter harsh environmental conditions: pathogens, for example, have to withstand acidity in the stomach. A specific stress response may help them to survive such stressful conditions. At the same time, the response to a specific stress factor may also protect the bacterium from another stress factor; this is known as cross-protection. In their study, first author and Ph.D student Karin Mitosch and colleagues investigate whether the stress response to antibiotics can also provide such cross-protection.

Antibiotics, i.e., drugs that kill bacteria or inhibit their growth, can also activate stress response genes. So far, it has been unclear whether this stress response may also protect bacteria against other environmental influences. To investigate this question, the researchers exposed the bacterium Escherichia coli to low concentrations of four different antibiotics. At the same time, they measured how transcription changes across the entire genome of the bacterium in response to the antibiotics. Transcription is the copying of DNA into mRNA, which in turn provides the instructions for protein production.

One of the antibiotics investigated, trimethoprim (TMP), induces a rapid acid stress response, which is very variable from one bacterial cell to another. Those bacterial cells with a strong stress response are better protected from a subsequent acid attack. When the researchers exposed bacterial populations to an extremely acidic hydrochloric acid solution, the bacteria died rapidly: their survival is measured as 'half-life'— similar to the decay of radioactive materials— and amounts to only about 30 minutes. When the researchers placed the bacterial populations into a solution containing low concentrations of TMP first, and only later into the hydrochloric acid solution, the half-life triples to over 100 minutes.

Mitosch and colleagues elucidated the biochemical mechanism on which this cross-protection is based. TMP leads to a depletion of adenine-nucleotides, an important building block of DNA and energy carrier in the cell. This depletion in turn induces the acid stress response. Karin Mitosch explains the importance of their findings: "We propose a way how to find cross-protection between antibiotics and other stress factors. This is important, as our study gives an example for how antibiotics can influence the survival chances of bacteria in different environmental conditions. If we understand which cross-protection exists, targeted strategies may be developed that enhance the effect of antibiotics in the treatment of diseases."

Tracking a Solvation Process Step by Step

Chemists of Ruhr-Universität Bochum tracked with unprecedented spatial resolution how individual water molecules attach to an organic molecule. They used low-temperature scanning tunneling microscopy to visualise the processes at a scale smaller than one nanometre. This allowed them to

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