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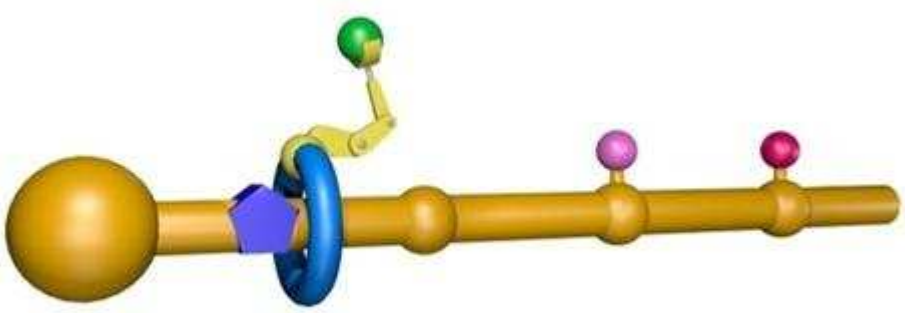
Molecular machines could lead to more efficient manufacturing

10 January 2013 | By Stephen Harris



Materials built by molecule-sized machines have moved a step closer to reality thanks to research at Manchester University.

A group of scientists led by Prof David Leigh have developed what they claim is the world's most complex synthetic molecular machine, one that can build other molecules in a similar way to how biological compounds such as proteins and DNA are created.

The work, published today in a paper in the journal *Science*, could lead to the creation of molecular machines that automatically synthesise materials without the need for a complex process of chemical reactions, or even help create entirely new materials.

Molecular machines are complex arrangements of atoms that are designed to react with and manipulate other molecules, driven by the natural random movement of particles.

'What people have done up to now is make molecular machines that can do very simple tasks like switch between different states and even do a limited amount of mechanical work, pull things a very small distance and so on,' Leigh told *The Engineer*.

'What we've come up with is a molecular machine that's able to build other molecules and that's not been done before.'

The new machine is based on a biological protein-building molecule called a ribosome, which consists of a ring-shaped molecule that includes a reactive arm and moves along a track, picking up other building block molecules and synthesising a new material.

Leigh explained that the movements of the molecules were random but that they were designed so that they could only react in the way and in the order needed to produce the new molecule.

'The ring is moving randomly up and down the track but it can't get past the building block,' he said. 'At some point the reactive arm on the ring will react with this building block and pull it off the track. Then the ring can move further down the track.'

The researchers hope that, one day, molecular machines could be used to more efficiently synthesise materials, in a similar way to how traditional manufacturing machines have enabled the more efficient production of goods.

'Today, every pharmaceutical, every polymer, every paint, every catalyst is made by people in the lab or factory mixing together chemicals,' said Leigh. 'It's lots of multi-step batch processes. Whereas with this sort of system we let the molecules do the work.'

He added that the first application of molecular machines may be to produce molecules that have not been made before, even in biological chemistry, which is based on just four types of polymer: DNA, RNA, proteins and carbohydrates.

The molecular machines themselves are gradually built up through a series of chemical reactions but Leigh described their development as a form of engineering.

'You start with the function you want it do and then you try and design the chemical structure that will allow you to do that,' he said.

'Lots of different components are doing different things. For example, the ring is there to ensure the building blocks are reached in order because otherwise it could step over those blocks and react out of turn. Then we need rigid spaces between the blocks so the track doesn't fold.'

'Different parts of the machine have different functions, and designing the parts so they don't interfere with the other parts is very challenging … We frequently found many times along the way that different parts of the structure were compromising another part.'

The next challenge will be to develop machines that can build molecules from a similar number of blocks to those used to make proteins – around 30 to 40 as opposed the four achieved so far.

Readers' comments (2)

- JohnK | 10 Jan 2013 1:29 pm

  Is this the 'Philosophers Stone"?

- Editor's comments | 10 Jan 2013 1:29 pm

  No. That transmuted elements.

- JohnK | 12 Jan 2013 9:57 am

  And do elements not comprise molecules, which this process claims to re-arrange/transmute. I stand by 'Philosophers stone'.....

- Editor's comments | 12 Jan 2013 9:57 am

  The elemental atoms aren't changed, just moved around like they are in a chemical reaction.

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