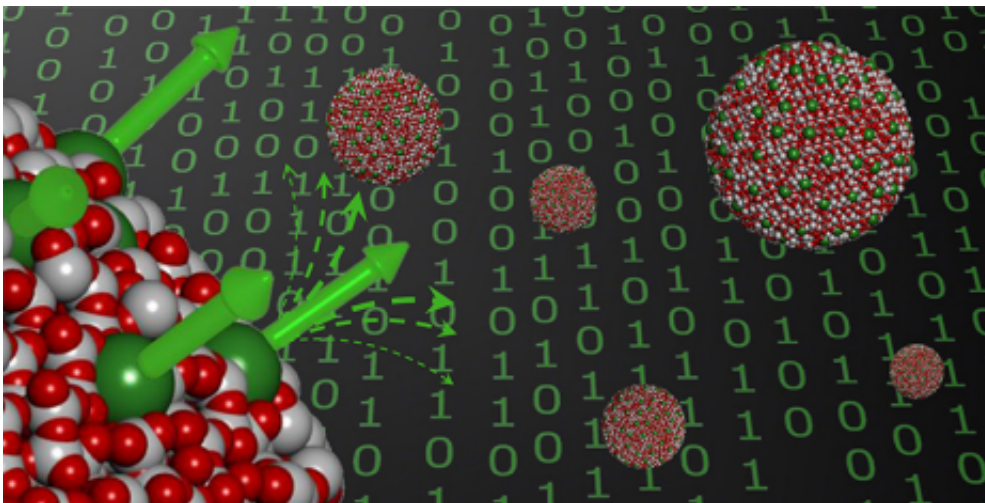


# Nanomagnets for future data storage

March 30 2017, by Fabio Bergamin

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Dysprosium atoms (green) on the surface of nanoparticles can be magnetised in only one of two possible directions: “spin up” or “spin down”. Credit: ETH Zurich / Université de Rennes

An international team of researchers led by chemists from ETH Zurich have developed a method for depositing single magnetisable atoms onto a surface. This is especially interesting for the development of new miniature data storage devices.

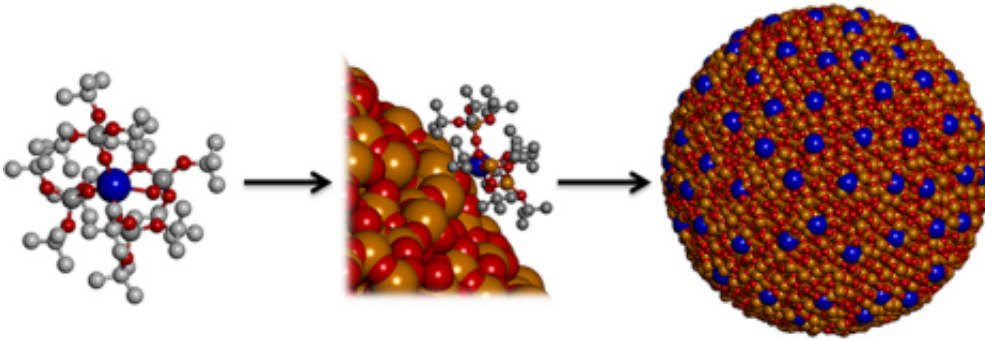
The idea is intriguing: if only a single atom or small molecule was needed for a single unit of data (a zero or a one in the case of binary digital technology), massive volumes of data could be stored in the tiniest amount of space. This is theoretically possible, because certain [atoms](#) can be magnetised in only one of two possible directions: "spin

up" or "spin down". Information could then be stored and read by the sequence of the molecules' magnetisation directions.

However, several obstacles still need to be overcome before single-molecule magnet [data storage](#) becomes a reality. Finding molecules that can store the magnetic information permanently and not just fleetingly is a challenge, and it is even more difficult to arrange these molecules on a solid surface to build data storage carriers. To address the latter problem, an international team of researchers led by chemists from ETH Zurich has now developed a new method that offers numerous advantages over other approaches.

## Fusing atoms to the surface

Christophe Copéret, a professor at the Laboratory of Inorganic Chemistry at ETH Zurich, and his team developed a molecule with a dysprosium atom at its centre (dysprosium is a metal belonging to the rare-earth elements). This atom is surrounded by a molecular scaffold that serves as a vehicle. The scientists also developed a method for depositing such molecules on the surface of silica nanoparticles and fusing them by annealing at 400 degrees Celsius. The molecular structure used as a vehicle disintegrates in the process, yielding nanoparticles with [dysprosium atoms](#) well-dispersed at their surface. The scientists showed that these atoms can be magnetised and maintain their magnetic information.



Molecules with a dysprosium atom (blue) at their centre are first deposited onto the surface of a silica nanoparticle (red and orange) and then fused with it.  
Credit: Allouche F et al. ACS Central Science 2017

The magnetisation process currently only works at around minus 270 degrees Celsius (near absolute zero), and the magnetisation can be maintained for up to one and a half minute. The scientists are therefore looking for methods that will allow the magnetisation to be stabilised at higher temperatures and for longer periods of time. They are also looking for ways to fuse atoms to a flat surface instead of to nanoparticles.

## Simple preparation

One of the advantages of the new method is its simplicity.

"Nanoparticles bonded with dysprosium can be made in any chemical laboratory. No cleanroom and complex equipment are required," says Florian Allouche, a doctoral student in Copéret's group. In addition, the magnetisable [nanoparticles](#) can be stored at room temperature and re-utilized.

Other preparation methods include the direct deposition of [individual atoms](#) onto a surface, yet the materials obtained are only stable at very

low temperatures mainly due to the agglomeration of these individual atoms. Alternatively, [molecules](#) with ideal magnetic properties can be deposited onto a [surface](#), but this immobilization often negatively affects the structure and the magnetic properties of the final object.

**More information:** Florian Allouche et al. Magnetic Memory from Site Isolated Dy(III) on Silica Materials, *ACS Central Science* (2017).  
[DOI: 10.1021/acscentsci.7b00035](https://doi.org/10.1021/acscentsci.7b00035)

Provided by ETH Zurich

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