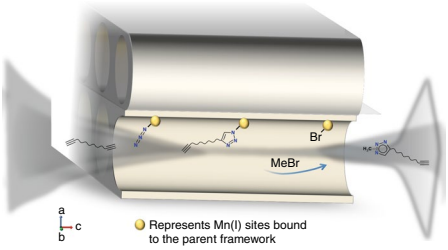
MOLECULAR ORGANIC FRAMEWORKS

Selectivity in one click

J. Am. Chem. Soc. http://doi.org/cpz7 (2018)



Credit: American Chemical Society

It is notoriously difficult to react only one alkyne moiety of a symmetric dialkyne with an azide, as both alkynes are likely to undergo a [3+2] cycloaddition reaction (a click-chemistry reaction) and form a bis-triazole. As a result, lengthy chemical protection and deprotection procedures have been developed. Now, Huxley et al. have reported a direct synthetic strategy to convert a symmetric dialkyne into an alkyne-functionalized triazole by taking advantage of the steric constrains that a metal–organic framework (MOF), used as a nanovessel, imposes on the reaction pathway.

The researchers first prepare a Mn-based MOF in which the Mn atoms are about 13 Å apart. They then substitute the bromine atoms, which are attached to each Mn, with an azide moiety, therefore creating an environment in which the azides are uniformly spaced within the pores of the MOF. When reacting the MOF with a short dialkyne, the only product of the reaction is a mono-triazole. This is because the dialkyne is shorter than the distance between the azides. When using a longer dialkyne, the researchers find a mixture of products including a bis-triazole. Finally, to release the product, they add methyl bromide, which displaces the alkyne-functionalized triazole and regenerates the initial Mn-based MOF.

All reactions are in the solid state and the crystallinity of the MOF is maintained throughout the process, thus providing researchers with a reliable ruler to control the selectivity of the reaction. *AM*

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2D MAGNETISM

Memory mille feuille

Science http://doi.org/cpz8 (2018)

The promise of low power consumption combined with the continued scaling of its components to higher density could see magnetoresistive random-access memory (MRAM) become a dominant type of memory technology in the foreseeable future. To this end, the recent discovery of 2D magnetism in chromium triiodide (CrI_3) creates opportunities for realizing atomically thin magnetic devices. To further illustrate this point, Song et al. have now reported layer-dependent tunnelling magnetoresistance (TMR) in a multiple-spin-filter magnetic tunnel junction (sf-MTJ) based on a 2D magnetic insulator CrI_3.

The proposed van der Waals sf-MTJ device consists of a thin bilayer, trilayer or four-layer CrI_3 tunnel barrier sandwiched between few-layer graphene and hexagonal boron nitride. In each case, CrI_3 acts as a spin filter in which the spin orientation of constituent layers can be tuned by a magnetic field, creating multiple magnetic states of thickness-dependent complexity. The tunnelling current in the sf-MTJs is highly sensitive to the net spin polarization in CrI_3 and can be greatly enhanced in the sample with fully aligned magnetization. The effect is especially pronounced in a four-layer CrI_3 that shows TMR of up to 19,000% for a magnetic field of 9 T at 2 K. *OB*

https://doi.org/10.1038/s41565-018-0175-2

MAGNETIC RESONANCE IMAGING

Diagnose lithium battery

Nat. Commun. **9**, 1776 (2018)

Magnetic resonance imaging (MRI) is a widely known medical imaging technique for diagnostics. However, its application in battery characterization is greatly limited due to the reliance of MRI on radiofrequency penetration, which can be easily impeded by the conductive enclosures in commercial cells. Now, Jerschow and co-workers employ MRI to non-destructively identify the state of charges and defects in a rechargeable lithium-ion cell without need for disassembly.

This is achieved by measuring permanent and small induced magnetic field changes using magnetic resonance methods. The magnetic susceptibility χ is material dependent and changes due to variation of the oxidation states of the anode and cathode materials during charge/discharge cycles. The researchers map the evolution of the magnetic field distribution over the cycles. By matching the magnetic field changes to the levels of charge, they can extract the magnetic susceptibility and information about the state of charge. Aside from examining the state of the lithium-ion cell over time, MRI is also capable of assessing the quality of the cell. It is very sensitive and thus not only identifies the flaws but also probes reproducibility of the cell construction. The MRI method for diagnosing remaining charge and cell health can come in handy in manufacturing processes. *WS*

https://doi.org/10.1038/s41565-018-0176-1

QUANTUM PHYSICS

Spinning the spin

Sci. Adv. **4**, eaar7691 (2018)

Rotating a quantum system at high frequencies opens a window to fundamental aspects of quantum mechanics, such as rotationally induced geometric phases, strain or magnetic fields. Yet, to initialize, control and readout a single quantum system in a rotating frame is challenging. Wood and co-workers now explore single nitrogen-vacancy (NV) centres in diamond spinning at high frequency and, by means of spin-echo interferometry, detect a modulation of the Zeeman shift induced by a 200,000 r.p.m. rotation of the spin qubit.

To track a single NV centre during the fast rotation, the researchers mounted the diamond onto a rotor and inserted it together with a microwave wire into a confocal scanning microscope. For the stroboscope-like experiments, they then synchronize the laser initialization of the spin qubit, its manipulation with microwave pulses, and the phase of the qubit rotation. As a proof-of-principle, a single NV centre serves as a rotating frame quantum sensor. A slightly misaligned magnetic field induces a modulated Zeeman splitting in the rotating spin qubit. Employing a spin-echo pulse sequence, the scientists measure the effective field modulation and determine the misalignment of the field with respect to the rotational axis. *BH*

https://doi.org/10.1038/s41565-018-0174-3

Olga Bubnova, Benjamin Heinrich, Alberto Moscatelli and Wenjie Sun