Science and Technology Facilities Council

SAQN STFC AIR QUALITY NETWORK

# Large Analytical Facilities

## Air Quality and STFC technology

**STFC is one of Europe's largest multidisciplinary research organisations supporting scientists and engineers world-wide. STFC operates world leading large-scale research facilities and manages the UK access to large-scale facilities in other countries. These facilities provide a wide range of techniques and experimental scope and can therefore be utilised by users from across the UK academic research community.**

STFC's ISIS Neutron and Muon Source (ISIS) is a centre for research in the physical and life sciences. The suite of neutron and muon instruments give unique insights into the properties of materials on the atomic scale. ISIS supports a national and international community of more than 3,000 scientists for research into subjects ranging from clean energy and the environment, pharmaceuticals and health care, through to nanotechnology and materials engineering, catalysis, polymers and fundamental studies of materials.

The Central Laser Facility (CLF) offers a wide-range of laser applications including experiments in physics, chemistry and biology, novel means of accelerating subatomic particles to high energies, probing chemical reactions and studying biochemical and biophysical processes. The laser facilities range from advanced, compact tuneable lasers which can analyse individual particles (e.g. aerosols) to high power laser installations that recreate the conditions inside stars. The primary purpose of the CLF is to serve leading national and international research communities that are operating at the forefront of their respective fields and need access to the most advanced and sophisticated facilities available.

The Diamond Light Source (Diamond) is the UK's synchrotron and is a partnership between the UK government (through STFC) and The Wellcome Trust. It works like a giant microscope, harnessing the power of electrons to produce bright light 10 billion times brighter than the Sun. These bright beams are directed into laboratories known as 'beamlines'. Here, scientists use the light to study a vast range of subject matter, from new medicines and treatments for disease to innovative engineering and cutting-edge technology. Over 9,000 researchers from both academia and industry use Diamond to conduct experiments.

### Case study – Adsorption of sulphur dioxide

An international team of researchers, led by scientists from the University of Manchester, have developed a new material that can reversibly adsorb sulphur dioxide ($SO_2$) from waste gas streams.

Toxic $SO_2$ emissions have severe effects on human health and the environment, even in trace amounts. State-of-the-art technologies to remove $SO_2$ from pollution sources rely heavily on the use of limestone, remove just 60-95% of the toxic gas and generate huge amounts of waste solids and water, resulting in significant environmental impacts. Research into new technologies for reversible $SO_2$ capture is urgent but is challenging due to the highly corrosive nature of $SO_2$.

The Manchester group developed a metal-organic framework (MOF), MFM-170, that can selectively take in toxic sulphur dioxide gas at record concentrations and preserve it for use in chemical production.

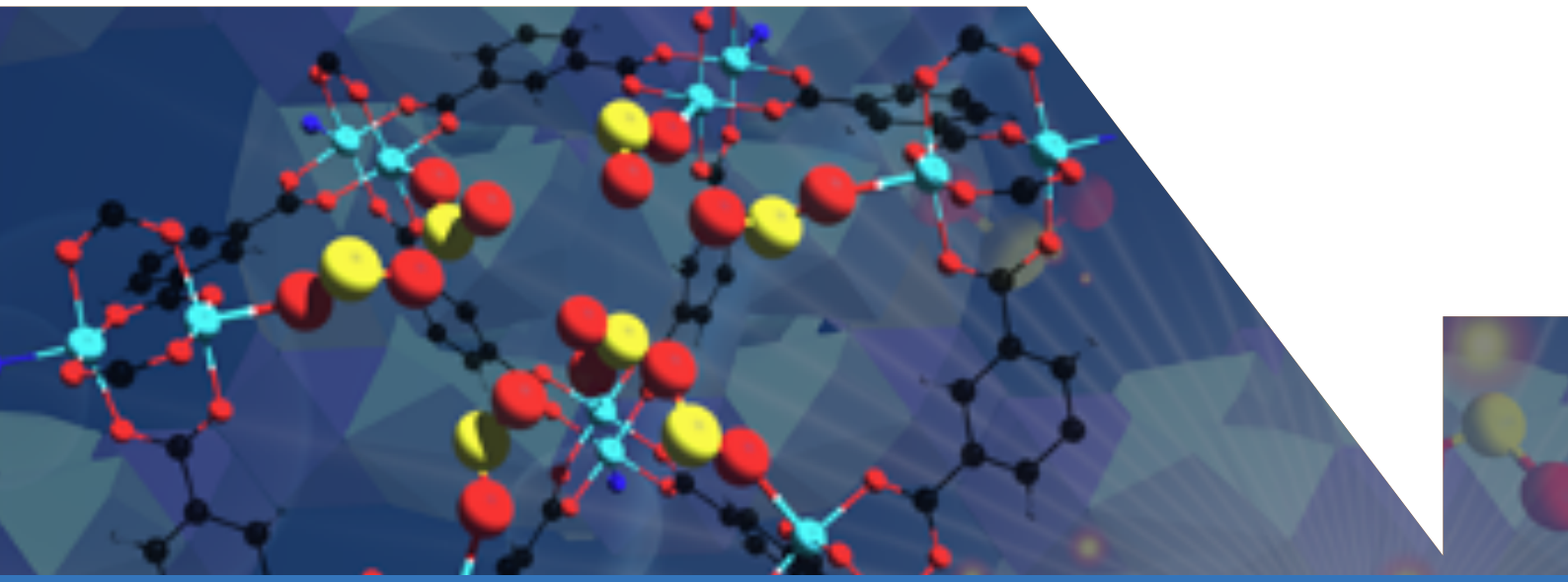
By doing state-of-the-art structural, dynamic and modelling studies at STFC's National Facilities such as ISIS and Diamond to conduct neutron and X-ray scattering experiments, and the Advanced Light Source in Berkeley USA to conduct single crystal diffraction work, the researchers have been able to determine the precise host-guest binding of the $SO_2$ within MFM-170 at a molecular level. Neutrons are very sensitive to lighter elements and the high spectral resolution of the TOSCA beamline at ISIS allowed the team to successfully answer challenging questions on how trapped water and sulphur dioxide molecules interact with each other and the MOF.

MFM-170 shows an adsorption of $SO_2$ higher than any other currently known porous material. This work is unprecedented as, unlike many other MOFs, MFM-170 is remarkably stable when exposed to $SO_2$, even in the presence of water, and the adsorption is fully reversible at room temperature. The MOF is able to capture $SO_2$ from humid waste gas streams, and when released the $SO_2$ can be converted to useful products, whilst the metal-organic framework can be reused for many more separation cycles.

Illustration of sulphur dioxide captured within the material, MFM-170

## Facility access

| Facility | Method of access | Cost | Contact information |
|---|---|---|---|
| ISIS Neutron and Muon Source, RAL | Applications 6 monthly (a period of shut down takes place during 2021) | Free at the point of access for academics | www.isis.stfc.ac.uk |
| CLF's Vulcan, Astra, Gemini high power lasers, RAL | Applications 6 monthly | Free at the point of access for academics | www.clf.stfc.ac.uk |
| CLF's Octopus and Ultra facilities in the Research Complex at Harwell, RAL | Applications 6 monthly | Free at the point of access for academics | www.clf.stfc.ac.uk |
| Diamond Light Source | Applications 6 monthly (standard route), Rapid Access applications also available | Free at the point of access providing results are published | www.diamond.ac.uk |



This factsheet was produced by the Science & Technology Facilities Council Air Quality Network (SAQN) to support air quality researchers to access STFC capabilities. For more information on the network visit www.saqn.org